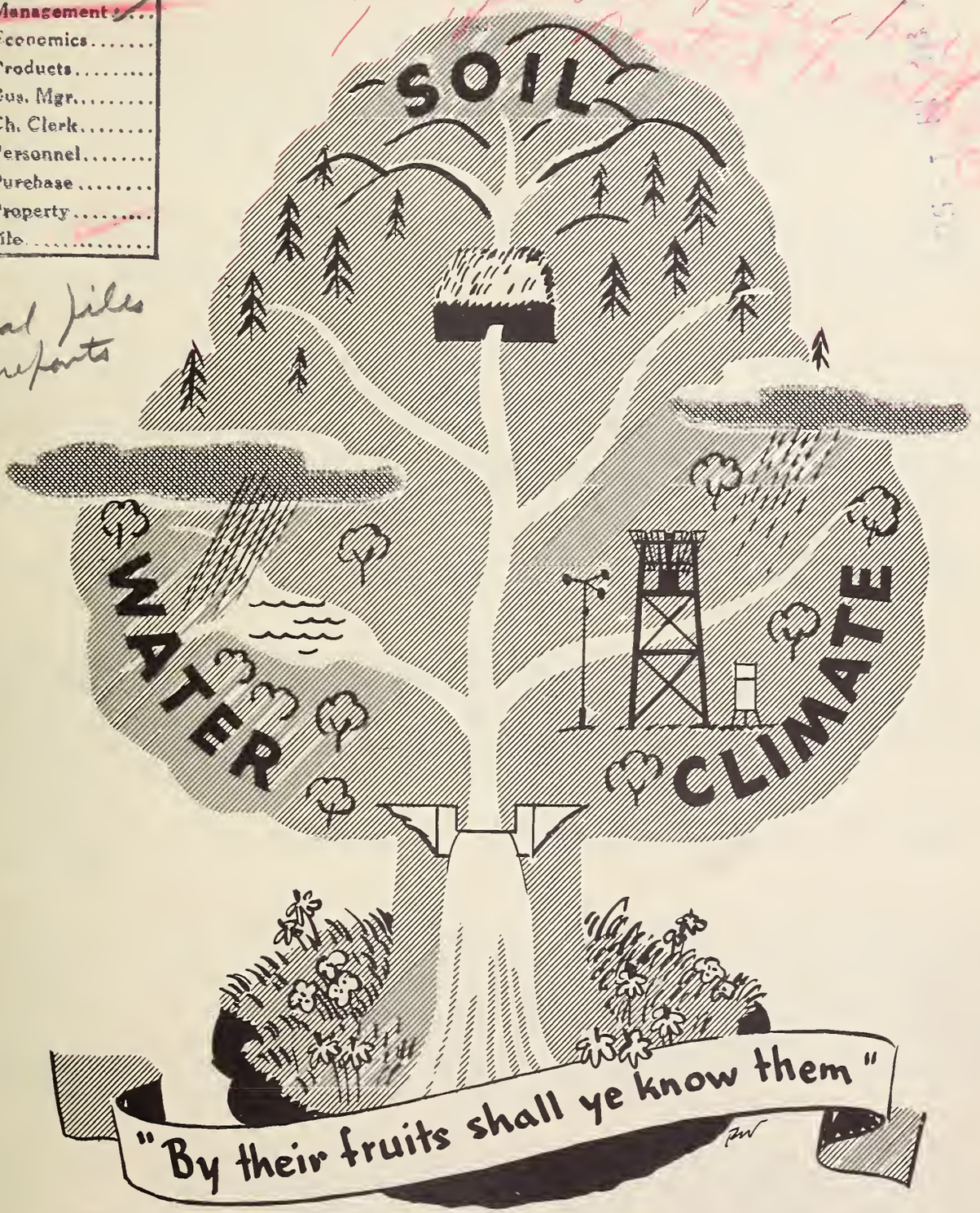
DIVISION OF FOREST INFLUENCES

Semiannual

Quarterly Report



U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

July-September 1953

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SEMIANNUAL REPORT
Division of Forest and Range Influences
April - September 1953

Washington Office Activities

The last several months have been a busy period indeed. Much time has been spent on such matters as reviewing technical manuscripts, participating in FIARBC Hydrologic Subcommittee meetings, preparing Research proposals, lecturing to foreign trainees, and field inspection. Following are some of the activities which fell to the Division's lot during the period.

Contributed material for and participated in discussions on preparation of article by Reader's Digest on national forest watershed problems and programs with special emphasis on watershed aspects of management on both public and private lands.

Consulted by Prof. Jean Gottman, Institute for Advanced Studies at Princeton, on watershed and other land and water conditions in State of Virginia; Dr. Gottman is making a study of the State of Virginia as a case study in regionalism. During part of the period he has been assisted by a French Forester--Mr. Morel--who previously visited the United States to study forest and range influences, among other programs.

Prepared influences research inspection check list requested by Division of Operation.

Prepared summary of influences research accomplishments 1929 to date for Mr. Paul Rudolph of Lake States Station who has been assigned to prepare an article on accomplishments under the McSweeney-McNary Research Act. Also had opportunity to make revisions or corrections in his article prior to its submission to Dr. Harper.

Participated in several meetings of Departmental Committee on 1955 USDA Yearbook on Water.

Attended discussion on evapotranspiration by Dr. Penman of Rothamsted Experiment Station. Penman disagrees with Veihmeyer that the rate of transpiration remains constant even though soil moisture decreases. Dr. Kellogg (SCS) also questioned this view at the meeting, as well as the methods used by Veihmeyer. (Comments by this office on Veihmeyer's views, as expressed in an article in the AGU Transactions and also on a paper submitted by him to various persons, have been prepared and submitted to the AGU for publication.)

A rubber model of Coweeta has been prepared for a Department exhibit in November; this shows the experimental watersheds, major installations, and the underlying geologic structure, painted around the vertical border of the model; this additional feature has been made possible by the excellent description transmitted by Charlie Hursh at our request. Photographic enlargements illustrating the experimental work will accompany the model.

(Over)

Participated in several foreign trainee orientation lectures. At the request of a mixed European group of foresters, agronomists, and engineers, a special session was held on the Davis County contour trenches; the discussion on trench design was illustrated by blackboard drawings based on Bailey and Croft's ECW bulletin published some years ago.

Prepared a progress and proposal report for consideration by the Forest Research Advisory Committee. The proposals submitted are as follows:

a. Classifying timber areas for logging purposes and developing improved logging methods, particularly on critical watersheds (nationwide).

b. Revegetating silt-source areas in the West.

c. Controlling phreatophytes.

d. Reducing fire on critical watersheds in southern California and other chaparral areas via the development of fire- (as well as drought-) resistant vegetation.

These suggestions have grown in whole or in part out of the findings of Influences Research and the problems pointed up to date. The last item comes from extended discussions with Art Brown, Chief of Fire Research. This proposal would represent an adaptation of the present southern California research in drought-resistant plants adapted to the chaparral region. (At its meeting on October 27, 1953 all of the above proposals were discussed and unanimously approved by the Forest Research Advisory Committee.)

Discussion

Infiltration

How meaningful are the results of infiltration tests when used to obtain a measure of the rates of surface runoff and soil loss from "rains" of given intensities and amounts? For example, how and by how much would the rates of soil displacement and runoff vary as between an actual rain with an intensity of 5 inches per hour for 15 minutes, and an infiltrometer test involving the same rates and amount of water? Quite frequently in research reports, data derived from infiltrometer runs are given the same weight as those derived from actual rains. In view of the limited area wetted by infiltrometer "rain" and the marked differences in raindrop velocity, discrepancies in effects as compared with those obtained from actually measured rains are bound to occur. If the results of infiltrometer tests could be qualified by the application of some appropriate converting factors to indicate the expected values from rains of similar intensities and amounts on the same plots, it is believed that the meaningfulness of expanding infiltration values to larger areas and of apportioning streamflow back to the various soil cover complexes on the watersheds could greatly be enhanced. Certainly we could expect the predictability of the results to be considerably improved.

All this brings up again the question of the large vs. small infiltrometers. Personally I believe that an infiltrometer would need to be many, many times larger than the largest one now in use in order to approximate actual rainfall

even remotely. Even if it were possible to apply water in large amounts over a considerable area, we still would not be getting the raindrop impact effect that is of such great importance in our tests. So it seems to boil down to a matter of deriving some useful correlations between tests with such infiltrometers as we now possess and measurements from actual rains.

Both this office and Ted Osborne would appreciate knowing about any data which may indicate reliable correlations between natural and artificial rainfall. And of course any comments--pro or con--on this question are always welcome!

SEMIANNUAL REPORT -- APRIL-SEPTEMBER 1953

Forest Influences Division

California Forest and Range Experiment Station

GENERAL

Increasing interest is being shown in watershed management in the West by organizations other than the Forest Service. This can well lead to increased activity in Influences research, both inside and outside the Service, if those of us in research can make clear the kinds of watershed management problems that are in need of solution. One example of increasing interest was shown at a meeting held in San Francisco on September 30. The meeting was called by the Natural Resources Department of the Chamber of Commerce of the United States, to discuss the management and disposition of federally-owned lands. One of the subjects discussed was the watershed values of federal lands, and considerable emphasis was placed upon the need to manage all wildlands in the West for the protection of water supplies.

A second example is the report of a Task Group of the American Water Works Association ("Erosion Control in Reservoir Areas", Journal A.W.W.A. 45:790-794. 1953) which points out that water works engineers must be concerned with the condition of the lands tributary to their works.

The third example, which strikes close to home here in California, is a recent action of the Los Angeles County Flood Control District. This organization is allocating $15,000 to the Forest Experiment Station for the current fiscal year to aid our research on cover improvement in the Los Angeles River watershed.

Personnel

C. J. Kraebel was designated a member of the committee to compile the present knowledge of forest regeneration in California, under auspices of the California State Board of Forestry.

W. C. Ashby left the Forest Experiment Station August 31, to accept a position with the California Institute of Technology, in Pasadena. His new work will be in the field of plant-water relations, some of it in cooperation with the Station.

Fire

Thus far during 1953, southern California has suffered more than its usual quota of fires. In fact, nearly 60,000 acres have been burned on the Angeles National Forest alone, the greatest area since 1924. In addition to helping with fire suppression, San Dimas staff men have been called upon to give recommendations for cover crop sowing on the denuded watersheds.

The Sulphur burn covered 32,400 acres, mainly in the Little Rock drainage on the northern or desert side of the Angeles Forest. The local people were much concerned about sedimentation in the Little Rock Reservoir because two-thirds of its drainage had been burned-over. A field trip on July 24 to the burn was sponsored by the Palmdale Irrigation District. Sinclair, with Mendenhall, Howlett, and Beardsley of the Angeles National Forest, took part in the field trip and a meeting held the same day at Lancaster to consider measures that might be taken to reduce potential flood and erosion damages. Seeding of the most favorable sites of the burned area was recommended by the Forest Service as a feasible remedial measure. The sowing plan developed by the Station recognized that much of the burned area was on open rocky desert slopes, and only 8,500 acres were considered to have sufficient soil to be suitable for sowing. A mixture of Italian ryegrass (Lolium multiflorum) and black mustard (Brassica nigra) was recommended for the acres to be sown in the Little Rock watershed. The north slopes of Pleasant Ridge, which drain directly into farm lands, will be sown to grass only. In addition to the Italian ryegrass, the lower slopes of the Ridge will be sown with two strains of wild oats furnished by the Soil Conservation Service.

The 650-acre Maddock burn in the foothills directly north of Duarte, on the south side of the Angeles Forest, is to be sown to Italian ryegrass only. More than half of this burn is outside the Forest. Los Angeles County Department of Forestry is financing the sowing of private lands in both the Sulphur and Maddock burns.

The Arrowhead Springs fire burned 3,600 acres in the Strawberry and Harrison Creek drainages of the San Bernardino National Forest. These watersheds drain into water conservation and flood control works which will suffer from debris deposition, and which may not be sufficient to protect the city of San Bernardino from damage in case of a large storm. Local interest in these flood hazards has been very high, and aid for sowing has been granted by the Board of Supervisors of San Bernardino County. Plans made in cooperation with the Soil Conservation Service call for seeding 500 acres, including all of Harrison Creek and a portion of lower Strawberry Creek, to a mixture of black mustard and Italian ryegrass. The remainder of the burn below 5,000 feet will be sown to black mustard except for some rocky areas in the eastern portion of the Strawberry Creek drainage.

The Fish Fork fire was started by lightning September 9 in a remote part of the East Fork of the San Gabriel River Canyon. Before this fire was brought under control nearly two weeks later, 22,500 acres had burned in spite of the efforts of one of the largest forces of men and equipment to be assembled on a fire in California history. Most of the area burned was roadless and many of the crews and spike camps were serviced by mule train, helicopter, or airplane. The Glendora office served as headquarters for coordinating the fire control work.

The southern part of the fire, during its progress, became a potential threat to the San Dimas Forest. A firebreak was cleared along the northern boundary ridge of the Experimental Forest, extending east and west a total distance of some 20 miles, for use had the fire continued to spread southward in the San Gabriel drainage. Owing to the generally high elevation of the burned area and the steep rocky terrain, almost none of the burn is suitable for sowing either to grass or to mustard.

Research Planning

In the early part of June, Colman spent several days with the San Dimas staff discussing future research plans for the San Dimas Experimental Forest. The following decisions were made:

1. Installations for the study of rainfall disposition under brush, grass, and pine forest on plots near Tanbark Flat would be completed as soon as possible. Every effort would be made to calibrate the 175 fiberglas soil moisture units installed in these plots. Runoff troughs would be installed in the pine plots before the rainy season of 1953-54. An interception study would be made in the grass-covered plots. Progress has been made on all these points since the meeting.

2. A new set of brush plots would be installed if a site with suitable soil can be found. The present brush plots are not desirable because lying adjacent to the grass plots, roots from the brush will eventually invade the grass area. With soil depths ranging from 6 to 17 feet, trenching or other mechanical means of controlling root invasion are economically out of the question. The plan agreed upon was to find another set of brush plots nearby, compare the moisture disposition there for several years with that of the present brush plots, and then remove the brush from the present ones and sow them to grass to eliminate brush root invasion into the grass study area. The new brush plots have not yet been located. When they have been they will be equipped similarly to those now in operation.

3. Vertical rain gage records of earlier years for the San Dimas Experimental Forest would be corrected and brought up-to-date as soon as possible, using methods developed in Hamilton's rain gage study. This work is progressing.

4. A work plan for streamflow analysis would be prepared as soon as possible. The purposes of the analysis are to establish relations between watershed characteristics and streamflow, and between storm and other weather characteristics and streamflow.

5. Plans would be prepared for research in water yield control by manipulation of riparian and slope vegetation. Lysimeter, plot, and watershed studies are to be included in this research. To date there has been considerable discussion of the directions this research might take, but no written plans have been prepared.

PUBLICATIONS

Manuscripts Published

"A Guide to the San Dimas Experimental Forest" by Sinclair and Hamilton has been issued as CF&RES Miscellaneous Paper No. 11.

"Indicators of Erosion on Watershed Land in California" by Gleason was published in June 1953 in the Transactions, A.G.U., Vol. 34, No. 3, pp. 419-426.

"Control of Evaporation from Rain Gages by Oil" by Hamilton and Andrews was published in the May 1953 Bulletin of the American Meteorological Society.

Manuscripts Submitted for Publication

"Erosion in the San Gabriel Mountains of California" by J. D. Sinclair, was presented by H. C. Storey at a Symposium on Land Erosion held by the American Geophysical Union at its May meeting in Washington D.C. This paper describes southern California's watershed erosion problems. H. W. Anderson's paper "Suspended Sediment Discharge as Related to Streamflow, Soils, Topography, and Land Use" was also presented as part of the Symposium. Both papers have been submitted to the A.G.U. for publication.

"Detecting Hydrologic Effects of Changes in Watershed Condition", by Anderson has been submitted to the American Geophysical Union for publication. This paper and the one above were discussed in recent Quarterly Reports.

E. A. Colman's book "Vegetation and Watershed Management" is scheduled for publication November 15 by the Ronald Press Company of New York.

Manuscripts in Preparation

Rowe presented his paper, "Effects of the Forest Floor on Disposition of Rainfall in Pine Stands", at the annual meeting of the Society of American Foresters at Colorado Springs in September. It will be submitted for publication in the Journal of Forestry. This paper presents results of a series of experiments designed to measure (1) evaporation from forest floors of pine stands in California, and

(2) the influence of these floors on surface runoff, percolation, and evaporation from the soil. Average annual evaporation from a floor under ponderosa pine ranged from 1.5 inches when the floor was 1 inch deep, to 2.6 inches when the floor was 3.6 inches deep. During the winter season, when storms were frequent and the floors continuously wet, evaporation was unaffected by the depth of the floor. When the floors were covered with snow, evaporation was negligible. During the drying period of spring and summer and the wetting period of fall, evaporation from the floor was greater when storms were more frequent. The deepest floors, with the highest water storage capacities, lost the greatest amount of water. In lysimeters, surface runoff and evaporation were much greater and percolation correspondingly less from bare than from forest-floor-covered soils. Percolation started later and ended earlier each year from the bare than from the covered soils. Forest floors 1/2 to 1 inch in depth appeared to provide better control over water than did greater or lesser depths. The intermediate depths held to a minimum the combined losses of water as surface flow and evaporation from the soil, hence releasing the greatest quantity for vegetation use and percolation.

"Rainfall Sampling on Rugged Terrain" by E. L. Hamilton, planned for publication as a U.S.D.A. Technical Bulletin, has been returned to the author after being reviewed by a Forest Service Board of Review. It will be submitted in final form very soon.

The following papers are now in various stages of Division review and revision:

"Temperature Requirements for Germination in Relation to Wild Land Reseeding" by W. C. Ashby and H. Hellmers. This paper was presented in June by Ashby at the Santa Barbara meeting of the Pacific Division of the American Association for the Advancement of Science.

"Root Systems of Some Chaparral Plants in Southern California" by Heldmers, Juhren, Horton, and O'Keefe.

"Fertility Levels of Three Residual Soils of the San Gabriel Mountains, California" by Hellmers, Bonner, and Kelleher.

"Development of Vegetation after Fire in the Chamise Chaparral of Southern California" by Horton and Kraebel, is ready for review by the Station editor. This paper, intended for publication in one of the ecological journals, discusses plant succession after fire in the chamise type, and gives the results of 20 years of plot studies in southern California.

"Some Aspects of Watershed Management in Southern California" has been revised in preparation for its reissue. It was originally published as CF&RES Miscellaneous Paper No. 1.

An outline for a paper entitled "Structure of the Southern California Chaparral" has been prepared by Horton and has been submitted to the SDEF staff for review.

CURRENT RESEARCH

SNOW STUDIES

Analysis of snow water storage and ablation in the Sierra Nevada has continued, making use of data collected at the Central Sierra Snow Laboratory by the Corps of Engineers and the Weather Bureau. The objectives of the analyses were outlined in the Quarterly Report for January-March 1953. Two important characteristics of the snow pack were selected for analysis: the April 1 water equivalent of the pack, and the rate of ablation of the pack after that date. Analyses to date have been confined to studies of the rate of ablation: first selecting a sensitive rate function and then testing how that rate function varied with forest cover condition. Because these methods of analysis may be of use to other stations, and because we should welcome commends from other workers, the method is given in detail as follows:

The rate function was to be the change in water equivalent per some unit of degree-days of air temperature. Degree-days above 32°F. was found to be fairly well related to ablation rate; the relation was not improved by including degree-days below 32°. However, there was some indication that the relation to degree-days above 32° was not linear. When degree-days above 35° was used, the relation to ablation was found to be linear. Hence, degree-days above 35° was chosen as the unit to be used. This unit has also been found useful by other workers. For the analyses that were made, inclusion of snowfall after April 1 as a variable did not significantly improve the estimation of ablation. The reason for this may lie in the small quantity of snow usually delivered after April 1.

The degree-days above 35°, measured at nearby Soda Springs and corrected for elevation of each snow course by using the normal lapse rate, were summed from April 1 of a year to the date of each snow measurement. The number of snow measurements made at a sampling point or snow course during a melt season ranged from 4 to 13. For 146 sets of such measurements and associated degree-days of temperature, the constants in the equation Swe = Sn -Ab x T were determined by the method of least squares. In this equation: Swe is the water equivalent of the pack, in inches; Sn is the intercept on Swe at T = 0, that is, the April 1 water equivalent; Ab is the rate of ablation in inches per degree-day; and T is the degree-days above 35°F. summed from April 1 to and including the day of snow measurement. Sn ranged from 23 to 98 inches. Ab ranged from 0.05 to 0.26 inches per degree-day, differing between sampling points and between years. The standard error of estimate of Swe ranged from less than 1 to nearly 5 inches.

Despite year-to-year variation in the ablation rates, the effect of the forest on these rates could be evaluated if the forest cover at each of the snow measurement points could be characterized. Forest cover was characterized in terms of shade effectiveness, which was defined as the relative duration of shade at the measurement point during the period April 1 to June 15 multiplied by the relative solar energy which would have impinged on the snow surface were it not for the forest shade. The physical data used in the calculation were: (1) the height of the trees above the snow measuring point, the horizontal distance of the trees from the snow measuring point (determined separately by azimuth segments 90-135, 135-180, 180-225, and 225-270), and (2) the solar energy as of May 12 (the time of mean ablation), at the mean of the above azimuth segments, received by course slopes from 0 to 50 percent and aspects N, NE, E, etc.[1/]

1/ Tabulations of Sin θ, at latitude 34°, for hour angles by 30° intervals, slopes by 10 percent intervals to 100 percent, and azimuths by 45° intervals, were compiled several years ago under the direction of Fons (Fire Division, CF&RES). These greatly facilitated the calculations.

Weighting shade duration by solar energy gave an index of shade effectiveness, Sh, at a snow point.

The relation of ablation rates, Ab, to forest shade, Sh, was tested using data for 3 years (1949, 1950, and 1951) from 5 snow courses, with 4 snow measurement points each (two with low values of Sh and two with high values.) The following covariance analysis table gives the results of the tests:

Source of variance	DF	Sh^2	ShxAb	Ab^2	Regression coefficient	Error of estimate: Sum sq.	df	Mean sq.
Total	59	84,623.4	-45.7491	.08750	-.0005406	.06312	58	
Betw. yrs.	2	0	0	.03254		.03254	2	.01627**
Betw. courses same yrs.	12	36,957.9	-11.4361	.01765	-.0003094	.01411	11	.00128**
Within course and yrs.	45	47,665.5	-34.3130	.03766	-.000720	.01296	44	.00029
Individual regressions						.00839	30	.00028
Diff. between individual and within regressions						.00454	14	.00032NS
Diff. between regression of means and within regressions						.00355	1	.00355**

Of primary importance to this study is the fact that the within-course-and-years regression (which gives the change in ablation with change in forest shading as -.00072) can be used for all courses and years because it does not differ significantly from the individual regressions. Incidentally, the t-test for this regression coefficient gave t = 6.8, which is greater than t = 2.69, the 1 percent level of significance. Quantitatively, the regression coefficient indicates that the ablation under full forest shade is about 60 percent of that in the open. (The high significance of the between-years and between-courses same years tests indicate that either the means or variances of the ablation rates of courses and years are different, even after adjustment for differences in forest shade.) The regression of Swe on T and the within regression coefficient of Ab on Sh can be used to estimate ablation for various courses and years. Comparisons between these estimates and the measured ablation will be made for other variations in physical conditions: differences in species making up for the forest stand, location of the forest stand relative to the snow measurement point, dimensions and orientation of forest openings, and topography of the site. These comparisons may suggest ways of removing some of the unexplained differences in ablation between courses and years.

The results of the current snow analyses, it is hoped, will show which influences of the forest on snow can be evaluated from present knowledge and which will require further basic physical measurements in the laboratory and field.

FIRE CASE HISTORY STUDY

The analysis of erosion observations from 92 burned-over brushland areas which were examined in the winter 1950-51 was continued, seeking relations between erosion and intensity of burn, soil texture, parent material (geology), and rainfall (see Quarterly Report, October-December 1952). Erosion was found to increase with intensity of burn, which was classified according to the extent to which the plant cover had been consumed. That is, low to moderate erosion occurred mostly in light to moderate burns; severe erosion was found, with one exception, only in moderate and hot burns; and the two cases of very severe erosion both occurred in hot burns. No relation between erosion and age of burn could be detected because two-thirds of the burns studied were one year old and there was insufficient sampling of the older age classes. (No appreciable erosion occurred in four of the one-year burns, but erosion was moderate to heavy in two 17-year burns.) No difference in erosion severity could be detected between burns on sandy and clayey soils, or between those on several kinds of parent material.

It was necessary to find out how unusual the 1950-51 winter season was with respect to erosion potential. If a winter such as this could be expected only once in 50 years the results of the study would be much less significant than if the winter were such as might be expected every 2 or

3 years. Rainfall records were found to be of little value for characterizing this winter because few rain gages were located in the study areas, and records of rainfall intensity were very short. Annual peak flows of streams within the study areas were therefore selected as the basis for making the determination. Such flows have been found by Anderson[2/] to be

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2/ Anderson, Henry W. Flood frequencies and sedimentation from forest watersheds. Trans. A.G.U. Vol. 30, No. 4. Aug. 1949, pp. 567-586.

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highly correlated with the sediment production of watersheds in southern California.

The peak flow analysis showed that annual peak discharges equal to or greater than those of 1950-51 had a return interval of only 2 to 7 years on streams draining the areas studied. Even though the greatest peak flows of record occurred in 1950-51 on several large rivers that rise at altitudes of 9,000 feet and more in adjacent watersheds, the winter was not at all unusual with respect to erosion potential in the areas studied, which lay below 4,000 feet altitude. It follows that erosion equalling or exceeding that of 1950-51 may be expected to occur in these areas every 2 to 7 years, on the average, on burned-over lands similar to those studied.

These determinations complete the analysis of data from the 1950-51 examination. In order to make the information obtained generally available without undue delay, it will be prepared for publication separately from the individual case histories of burns in southern California which, in the initial plan for the Fire Case History Study, were to be included.

LOGGING EROSION STUDY

Failure to follow well-known principles of road construction, and especially of drainage, is responsible for the greater part of the watershed damages in most logging areas in California. Many cases have been found where extreme erosion could have been prevented by some simple measure such as a water-break across a road or tractor trail. This project has revealed that either the know-how is not wide-spread enough, or more supervision is needed.

It has shown also, that bad location of roads, landings, and main skidways has resulted in much unnecessary damage. Numerous logging layouts have been efficient and profitable for the single purpose of getting out logs, but have caused heavy watershed damage. Such operations emphasize sharply that more careful advance planning must be applied to logging projects in mountain watersheds. Road locating, for example, is not as simple a task as it has been generally regarded. A high level of technical knowledge and skill must be exercised to detect and avoid locating roads through high erosion hazards such as seepage areas, excessively steep slopes, and unstable soils.

To illustrate the satisfactory layout of logging roads and landings, ground photographs have proven inadequate. Vertical air photos of the usual 1:20,000 scale failed to show the desired features in sufficient detail. For this reason large-scale oblique photos of several areas logged in recent years were taken from a Forest Service plane. These pictures, some taken of burned-area salvage projects, will help show good and bad features of logging road layouts. It is notable that one project, with an apparently well-planned system of contour roads, suffered spectacular erosion because of the washout of inadequately drained fills at some five or six stream crossings on each of the roads.

SAN DIMAS EXPERIMENTAL FOREST

Rainfall

Rainfall at Tanbark Flat for the hydrologic year 1952-53 ending September 30 was only 15.47 inches as compared to a 24-year average of 28.23 inches. This is the second driest year in the 24 years of record at Tanbark Flat. The year 1950-51 was the driest, with only 11.47 inches of precipitation.

Streamflow

The streamflow record for Watershed X (Monroe Canyon) has been brought up-to-date and all gaps in the record closed by extrapolation. A summary of data from the watershed follows:

	18-yr. average (1934-35 through 1951-52)	1952-53	
		Amount	Percent of 18-yr average
Precipitation	29.22 inches	15.88 inches	54.4
Streamflow	3.81 surface inches or 13.0 percent of average precipitation	.32 surface inches or 2.0 percent of 1952-53 precipitation	8.4

The effect of low rainfall in 1952-53 is clearly shown in the last column. With rainfall 54.4 percent of the 18-year mean, streamflow was only 8.4 percent of the annual average.

Lysimeters

Soil moisture samples were taken from each lysimeter containing fiberglas units for field calibration of these units. Sufficient samples have now been taken to draw satisfactory calibration curves showing the moisture-resistance relationship for most of the units. Adequate data for moist soil conditions are lacking for some units in the deeper soil layers of the brush and pine lysimeters. These data will be collected this coming rainy season if moisture penetrates deep enough. Data are lacking also for dry soil conditions for units in the deeper soil layers of the bare and grass-covered lysimeters because the soil has remained moist at those depths.

Evaporative moisture losses from the soil in the confined lysimeters planted to oak and to pine have been computed and are summarized in the following table:

Hydrologic year	Scrub oak: Winter (Oct. 1 to April 30)	Scrub oak: Summer (May 1 to Sept. 30)	Scrub oak: Total	Coulter pine: Winter (Oct. 1 to April 30)	Coulter pine: Summer (May 1 to Sept. 30)	Coulter pine: Total
	Inches of evapo-transpiration from 6 ft. of soil					
1948-49	3.5	11.6	15.1	6.8	7.9	14.7
49-50	7.9	12.2	20.1	12.6	6.1	18.7
50-51	5.0	6.8	11.8	8.1	1.8	9.9
51-52	7.6	15.0	22.6	9.9	13.9	23.8
52-53	8.5	8.6	17.1	11.4	2.3	13.7
Average	6.5	10.8	17.3	9.8	6.4	16.2

The average winter moisture loss from the pine lysimeter is over three inches more than that from the oak, while the summer loss from the pine averages over 4 inches less. This difference in seasonal water loss between the two species may have considerable significance in watershed management. If rainfall is sufficient during the winter months to wet through the mantle of a well-drained soil, a scrub-oak cover on that soil should permit more percolation through the soil than should a cover of Coulter pine. Both the oak and pine utilize all available water in the lysimeter soil during summers following normal or sub-normal rainy seasons. This indicates that the significant difference in water use between these species is more seasonal than annual.

The difference in annual water loss between oak and pine shown in the table above may be related to the greater infiltration capacity of the soil under the oak. The following table shows the average annual runoff and seepage figures for the oak and pine confined lysimeters. It shows about the same difference in surface runoff between lysimeters as is shown by the evaporative losses.

Species	Precipitation	Runoff	Seepage
	Inches of water (average of 5 seasons)		
Oak	22.24	5.12	0.22
Pine	22.24	6.54	0.14

It will be interesting to see whether these relations hold in the years to come, when the plants are larger, litter cover greater, and rainfall greater than normal.

Rainfall Disposition

Tanbark Plots.--In spite of the dry winter, an excellent stand of Italian ryegrass (Lolium multiflorum) developed on the grass-covered plots. At the peak of the grass development, in May 1953, the average vegetation density was 63 percent. The stand was uniform with very few open areas more than a foot across. Fifty-three percent of the plots was covered with ryegrass and the remaining ten percent with red brome (Bromus rubens), small flowered melicgrass (Melica imperfecta), and a scattering of miscellaneous herbs. The brush sprouts have been almost entirely killed by repeated spraying with 2,4,5-T.

During May a series of runs employing artificial rainfall was completed as a part of the grass interception study. At the time of these runs average density of the annual ryegrass cover was about 75 percent, and the average height about 8 inches. This cover intercepted and retained an average of about .08 inch of water during each wetting.

Soil moisture samples have been taken to calibrate the fiberglas soil moisture units in the brush, grass, and pine plots. In some cases fairly adequate calibration curves can be drawn but most units have not been sampled over a wide enough range of soil moisture to draw satisfactory curves. This work will continue through the coming rainy season.

LOS ANGELES RIVER WATERSHED

Soil Studies

The over-all objective of this study is to determine the effects of cover manipulation on the surface movement of materials (litter, soil, and rock) in various mountain land types of the Los Angeles River watershed. The present investigations are aimed at measuring rates at which these materials move toward the channels and determining the character of the materials. Collector troughs have been installed across five long-unburned slopes to catch the moving materials. These troughs cross the slopes on contour, generally starting near the point of a sloping ridge and ending as near to the main channel as feasible; the near-vertical walls close to some channels are too steep for trough installation. The hillside edges of the steel collector troughs have been carefully sealed to the slope with soil cement. Wood separators placed crosswise in the troughs at intervals of 20 feet or less limit the lateral movement of trapped materials, and divide the long troughs into a number of segments in which accumulations can be measured. On each study site the trough collects the surface-moving materials from a succession of more or less parallel strips extending from the trough up the slope to the ridge top. Proceeding across the slope on contour from the sloping ridge point to the channel, each strip becomes progressively longer, including more and more of the steeper sections of the slope.

The collection of material trapped during the current dry season is under way. All material collected is brought into the laboratory for determination of oven-dry weight, particle size, and organic content.

Cover Improvement Studies

Soil Adaptability.--Only routine greenhouse work has been done during the last six months; the series of plants started in the various soil types last winter are still not large enough to harvest.

Growth Studies.--Seeds of species recommended by overseas cooperators for erosion control work in southern California are still arriving. The most recent are six species from Italy. Exotic and native species grown under controlled temperatures during the past six months have been classified with respect to their growth at several temperatures (Quarterly Report, January-March 1953). The categories and species are:

A. Species whose growth at all temperature conditions falls within 33-167 percent of average growth:

Quercus dumosa	- California
Retama roetam	- Israel

B. Species favored by cool temperatures: None.

C. Species favored by moderate temperatures:

Cneoridium dumosum	- California
Sophora tetraptera	- Chile

D. Species favored by high temperatures:

Shinas dependens	- Chile
Calycotome villosa	- Israel
Cassia acuta	- Chile

The addition of a refrigerated room to the Earhart Laboratory at California Institute of Technology makes it possible to test plants for frost resistance. Replica plants from the growth study are being used to develop a rapid procedure for determining the frost resistance of exotic species.

A procedure to test drought resistance is also undergoing its first test. The procedure is designed to detect those species that are capable of going dormant when no water is available, and those species that are capable of surviving on an extremely low level of water, such as might be obtained from dew.

Plants of all exotic species tested are being grown for taxonomic identification. Some species have been planted within the fenced lysimeter area at Tanbark Flat. The others will be moved from the greenhouse to the field during the coming rainy season.

KINGS RIVER BRANCH

Analysis has been completed of the reactions of two of the Big Creek watersheds (Sierra National Forest) following their burning in 1951. A resume of the analysis as it stood at the end of the 1951-52 hydrologic year was given in the Station's Annual Report for 1952. Further analysis included the results of the 1952-53 hydrologic year. In the report mentioned above, it was stated that instantaneous streamflow peaks were slightly higher in 1951-52 than in 1936-37, before the burn

Detailed analysis of the streamflow data now has shown that neither storm flow nor ground water flow varied significantly from similar flows before the burn. Likewise, during 1951-52 and 1952-53 maximum instantaneous peaks were no different than in previous comparable years. A progress report is being prepared, to be followed by a paper for publication. Rainfall and streamflow measurements are being discontinued in view of the results obtained.

MEETINGS AND PROGRAMS

April 4.--Kraebel, Colman, and Gleason attended a demonstration control-burn in second growth ponderosa pine, staged by Professor H. H. Biswell, of the UC School of Forestry, at Hoberg's Resort in Lake County.

April 7-9.--An in-Service meeting of about 25 representatives from the Regional Office, the four southern California forests, and the California Station was held at Tanbark Flat to review the report of proposed policies for management of national-forest lands in southern California. The Experiment Station was represented by Wyckoff, Buck, Colman, and Sinclair.

May 4-6.--Wyckoff, Colman, Sinclair, Horton, Hellmers, Ashby, and Olson attended a Forest Service conference (Region 5 and Washington Office) held at Oak Grove Park, Pasadena, to review the work of the Los Angeles River Flood Control Project. The progress of cover improvement research conducted by the Station as a part of the Flood Control Project, and a proposed program for the continuation of this work (including studies of both vegetation and soil movement) were discussed by Colman and submitted to the group in a report prepared by the Influences Division. On a field trip to Mt. Lukens and Haines Canyon the group inspected one of the soil movement plots recently installed by Olson in the Arroyo Seco drainage.

June 23.--Colman and Gleason visited the UC Hopland Field Station in company with R. A. Burgy, in charge of experimental work under Professor F. J. Veihmeyer. At this new station the University is establishing a series of studies in range management and water yield. The trip gave on-the-ground opportunity to discuss mutual problems of forest and range influences.

July 1-3.--Anderson attended the joint meeting held at Portland, Oregon, between the Forest Service and Soil Conservation Service on policies and procedures under the new responsibilities of the SCS in Flood Prevention Surveys. Anderson presented some results of studies showing the effects of forest fires and logging on flood peaks, annual flows, sedimentation, and water quality for some watersheds of Oregon and California.

August 3-6.--Anderson attended a hydrology conference held in Portland, Oregon, between members of the Forest Service and Soil Conservation Service. The group reviewed and discussed procedures used in recently completed Flood Control Surveys in the West to evaluate the effects of land treatment on floods and sedimentation.

September 3-5.--Kraebel participated with UC Extension Forester Woodbridge Metcalf in putting on a general forestry demonstration at the annual convention of California 4-H Clubs, held on the UC campus at Davis. The demonstration covered the life cycle and functions of a forest and its relations to farm and city life, with emphasis on the influence of forests upon water supply.

A half-hour television show concerning the Los Angeles River Cover Improvement Program was presented by Hellmers and Ashby on Station KECA. This was a public service program arranged by the California Teachers Association in cooperation with the California public schools and the Los Angeles County Superintendent of Schools.

During the last six months staff members discussed the watershed research program with several groups. Sinclair gave talks to the Glendora and Claremont Kiwanis Clubs. Hellmers spoke to the Conservation Committee of Los Angeles Chamber of Commerce, explaining the cover improvement research being conducted in the Los Angeles River watershed.

COOPERATION

In May, Kraebel participated with Professor Herbert Mason, UC, as consultants with local conservation groups and the State Division of Parks in laying out a nature trail on the slopes of Mt. Tamalpais. This mountain is a prominent peak of the outer Coast Range, north of San Francisco Bay, which has heavy recreational use. Purpose of the trail is to demonstrate, by signs erected at appropriate points, the influences of forest cover upon water and soil erosion. This trail will be similar in many respects to the trail laid out some years ago by Frank and Tarnowsky in the Shenandoah National Park.

Mendocino National Forest.--In company with officers of the Mendocino National Forest, Kraebel and Colman examined salvage logging operations in the Boardman Ridge burn of 1952, logged in 1952, and made suggestions regarding the control of erosion resulting from the logging operations.

Sequoia National Forest.--Hamilton participated in a group examination of present conditions on the Cannel Meadows and Tule River Districts of the Sequoia National Forest. He represented the Influences Division of the Station with regard to the watershed management aspects of a proposal to open these areas to more intensive use. The Task Force was made up of Regional Office representatives for Land Use Planning, Roads, Timber, and Minerals, and California Station representatives for Soils and Watershed Management. The group covered about 150 miles by horse under the guidance of the Sequoia staff. A report based upon the group's examination is being prepared by the Regional Office.

Portland, Oregon, Flood Prevention Work Group.--At the request of Baudendistel, Anderson made an evaluation of the effects of the proposed USDA Flood Prevention program on sedimentation of Vaquero Reservoir (Santa Maria River Basin) and the consequent supply of water for irrigation in the Santa Maria Valley. The monetary benefits to water supply attributable to the program exceeded the flood prevention benefits estimated earlier when reservoir control of the floods was not considered for this watershed. An estimate was also made of possible sedimentation of the Santa Maria main channel after installation of the programs of the Bureau of Reclamation and the Corps of Engineers. This estimate indicated that in periods with relatively low flood flows, such as the last 39-year period, dangerous loss of channel capacity might be expected unless sediment production is reduced, as by the USDA program.

VISITORS

Javad Iranfar, of the Iranian Forest Service at Teheran, visited the Berkeley Station September 29, at the start of a 5-week stay in California. He is devoting a considerable part of his time to range and influences problems. Mr. Iranfar has not been particularly impressed by watershed deterioration in the American Southwest because conditions there are so much better than those he has been accustomed to. He explained that, because thousands of square miles in Iran have been heavily overgrazed for a thousand years, erosion has removed the topsoil and no traces remain of the original plant cover. In his opinion we are fortunate to be attempting wise land management before such damage is incurred in America.

The last six months saw the SDEF staff busy as usual with many visitors. One hundred and four people from California were shown over the Forest. The largest group consisted of 29 high school teachers who were studying science problems of southern California at Pomona College under the auspices of the Carnegie Foundation. Eleven visiting Forest Service men were also taken to Tanbark Flat. Foreign visitors included five from Pakistan, three from India, two from Formosa, and one each from England, Australia, Peru, Norway, Finland, Germany, and Japan.

FOREST INFLUENCES ACTIVITY

Buckeye Research Center

General

Carmean reported for duty on July 13. Most of his activities since that date have consisted of field trips and an examination of the files and publications of the Station. The present objective is for Carmean to gain knowledge of the region and of the current research problems now being studied by the Station.

The following field trips have been made:

a. July 14-15. Ohio Power Company field trip from Zanesville, Ohio. Spoil bank conditions and plantings were examined.

b. July 31. Society of American Foresters field trip from Cadiz, Ohio. Spoil bank conditions, plantings and experimental plots were examined.

c. August 3-25. General survey of the Station's experimental plots located in southeastern Ohio. This trip was made in the company of Limstrom and Finn who were making a periodic examination of Station experimental plots. Old field plantings and spoil banks were the major conditions observed.

d. September 21-25. A tour of forest and water research stations in southeastern Ohio with Merz. Centers visited included: SCS Hydrologic Laboratory at Coshocton, Ohio; Agricultural Experiment Station at Wooster, Ohio; and Muskingum Conservancy District at New Philadelphia, Ohio.

e. Carmean attended the Ohio Forestry Association Training Camp held at Camp Ohio, St. Louisville, Ohio. This meeting, held from August 24-28, was organized for the purpose of training youths of Ohio in the principles of forestry. Carmean was present from August 24-27 in the capacity of instructor in Forest Influences.

Carmean will attend the Soil Science Society of America meeting which will be held in Dallas, Texas from November 16-20. While in Dallas he will present a paper on the soil and site relationships of Douglas-fir in southwestern Washington. Carmean will also visit the Southern Experiment Station centers at Vicksburg, Oxford and Crossett. The week of November 9-13 will be devoted to these visits.

Field work

Nine rainfall recording stations were installed on the Vinton Furnace Experimental Forest. These stations were placed in operation on August 24 to provide continuous precipitation records. Relative humidity, maximum and minimum temperature and wind speed data will also be taken.

Plans

High priority will be given to completing a forest influence problem analysis for the Buckeye problem area. Tentative work plans include a continuation of the site index studies started by R. N. Gaiser. Species which will be studied may include black oak, red oak, chestnut oak, and shortleaf pine.

An examination of the Vinton Furnace Experimental Forest will be made in the near future for the purpose of locating and establishing small watersheds to be used for both hydrologic and management research. A detailed soils map for the forest will also be made.

Equipment will be set up in the laboratory at Athens for the purpose of making permeability and pore space determinations of undisturbed soil samples. The methods used will follow those described by Uhland and O'Neal (SCS-TP 101, 1951.)

SEMIANNUAL REPORT OF FOREST INFLUENCE INVESTIGATIONS
Intermountain Forest and Range Experiment Station
April - September 1953

Great Basin Research Center

The main effort at this center was the development of a first draft of a report on the behavior of the Area A and B watersheds covering the period 1916 to 1952. This report, intended for Departmental publication as a technical bulletin is now undergoing divisional review.

Reversal of Area B runoff and erosion behavior

As a new phase in the long-term study of storm runoff and erosion on the A and B experimental watersheds, Area B was plowed, contour-trenched, and seeded to grass in the fall of 1952. This treatment followed a period of several years during which Area B was heavily overgrazed in order to deplete the subalpine herbaceous plant cover. The object of the new treatment was to determine the effectiveness of intensive range improvement measures on curbing storm runoff and erosion on seriously depleted range. The first year of record following this treatment brought some gratifying results.

This treatment very effectively reduced the amount of soil washed from the watershed by 1953 spring snowmelt. During the spring of 1952, before treatment, 4.1 cubic feet per acre of sediment was eroded from Watershed A and 39.2 cubic feet per acre from Watershed B. This is an A-B ratio of almost 1 to 10. During the spring of 1953, 3.8 cubic feet per acre of sediment was eroded from Watershed A--nearly the same amount as in 1952. But there was only 0.3 cubic foot per acre of sediment eroded from Watershed B. Watershed A, therefore, out produced B over 11 to 1, and Area B produced less than one hundredth as much spring sediment in 1953 as in 1952 before treatment.

After 1953 spring snowmelt there was excellent initial establishment of seeded grasses. In June there was very little rainfall and it was feared there might be a high seedling mortality if the drought continued. During July, however, there was above normal rainfall. This not only insured excellent survival of seeded grasses but proved highly beneficial to forage growth on surrounding range areas. July was followed by low rainfall during August and September. Several of the July storms were of near record depths and intensities. During this period the effectiveness of the treatment on Watershed B was demonstrated even more vividly than during the snowmelt period.

Although Watershed A was in relatively good condition as a result of many years protection from overgrazing, four of the July storms (Table 1) caused more runoff and eroded more soil from the area than in any entire summer since 1937. However, during similar storms

earlier in the study when the watershed was in very depleted condition due to overgrazing, the volumes of soil loss were much greater.

Table 1.--Data for runoff producing storms, July 1953

Date	Rainfall Depth (Inches)		Max. 5-minute Intensity (in/hr.)		Soil eroded (Cubic ft/ac.)	
	A	B	A	B	A	B
7/10	0.67	0.65	2.04	1.80	6.4	0
7/28	0.51	0.72	1.80	1.56	12.3	Trace
7/30	0.91	1.34	2.28	2.52	30.2	5.8
7/31	0.60	0.58	1.20	0.96	5.8	Trace

Only one of these four storms, 1.34 inches on July 30, eroded a measurable quantity of soil from Watershed B. Although this storm was of record depth, the intensity was not as high as some previously recorded. There was only 5.8 cubic feet per acre soil loss. For all four storms the volume of soil loss per acre was 9 times greater from A than B.

This is a complete reversal of soil erosion ratios of recent summers when B was in depleted condition due to heavy grazing. A July 28, 1952 storm of 1.22 inches depth and maximum 5-minute intensity of 3.12 inches per hour eroded only 9 cubic feet per acre of sediment from A and 81 cubic feet per acre from B--an A/B ratio of 1 to 9. During the entire period from 1946 through 1952 summer storms eroded more soil from Watershed B than from Watershed A by a ratio of over 11 to 1.

The effectiveness of the treatment on Watershed B has apparently been due to a greatly increased depression and detention storage, and at least a temporary promotion of more rapid infiltration of water into the soil. By the time the temporary advantage is lost through soil compaction and leveling of the soil surface, the seeded vegetation should have developed to a point where it will hold the soil firmly in place.

Some Water Costs of Forage Production

Late in the fall of 1952 soil moisture samples were taken by 1-foot depth intervals under pure stands of smooth brome, timothy, and bluegrass, and under a mixed weed stand composed primarily of sweetsage and common dandelion. Collection of additional soils data and a recalculation of results has corroborated the preliminary findings. The total deficits in inches of water (the differences between field capacity and moisture present at time of sampling) from the soil surface to 5 feet were 7.86 inches under smooth brome, 7.07 inches under timothy, 6.00 inches under Kentucky bluegrass, and 5.49 inches under mixed weeds.

These are deficits which must be made up before spring snowmelt can contribute to ground water. From the standpoint of the maximum quantity of water that might become available for streamflow, smooth brome would be the least desirable cover and the mixed weeds as the most desirable. However, there are two other important considerations. The first is soil protection and stability. All three of the grass stands were adequate from this standpoint. The weed cover was not. The second consideration is weight of forage production. On a per acre basis, green weight, smooth brome produced 4,000 pounds, timothy 1,400 pounds, Kentucky bluegrass 2,000 pounds, and weeds around 700 pounds.

When summer rainfall is added to the fall soil moisture deficits, total evapo-transpiration losses were 11.33 inches under smooth brome, 10.54 inches under timothy, 9.47 inches under Kentucky bluegrass, and 8.96 inches under weeds. Smooth brome therefore produced about 350 pounds of green forage per inch of evapo-transpiration loss, timothy 135 pounds, Kentucky bluegrass 210 pounds, and weeds about 80 pounds.

The weed cover is obviously undesirable on three counts--inadequate soil protection, low forage production, and the least efficient water user, producing the lowest weight of forage per unit of water consumed. The relative desirability of the three grass species poses a problem in economics. All three provided adequate soil protection. But there is considerable difference in total weight of forage production and weight of production per unit of evapo-transpiration loss. If the quantity of water available for streamflow outweighs the value of higher forage production, Kentucky bluegrass would be most desirable. On the other hand, if highest forage production were the most desirable, smooth brome would unquestionably be superior. It is a problem of weighing water against forage values.

Plans are to replicate those preliminary tests, and to expand the study to include additional species in the subalpine zone and in the other elevational zones of Ephraim Canyon. The results should shed more light on the problem of plant species which will give the best balance of soil protection, water available for streamflow, and forage production.

Boise Research Center

Logging-Sediment Study Under Way

Since May, the influences staff at Boise has been pretty well pinned down with the installation of dams for catching sediment from the first replication of 8 compartments to be logged this year as part of a comprehensive study of managing ponderosa pine lands. The work of construction, still in progress, involves building of 11 dams with spillways, installation of permanent bench marks, establishing a grid system for sediment measuring coordinates in each catchment basin, and running the initial levels on these coordinates as a reference

for future sediment measurements. To date 9 of these dams have been completed except for running levels on the grid systems. The other 2 dams are still under construction but should be completed in October.

Following completion of the installation phase this fall a resurvey of each experimental watershed will be undertaken to determine the extent to which logging activity has affected watershed conditions.

Additional plans for post-logging work include testing the effects of different intensities of slash disposal on skid trails and different intensities of cross-ditching on spur roads. Initial sediment measurements on this replication are scheduled following runoff next spring.

Cooperative watershed demonstration

This spring the Regional office requested the Boise Forest to select a depleted watershed where they could demonstrate watershed restoration and improvement measures. At request of the region and Boise Forest the Research Center staff cooperated in locating a suitable watershed, planning a restoration program, and in initiating the program on the ground. After looking at many areas, the Headquarters watershed at the Arrowrock Substation in the foothill range type was selected. The present action program involves reseeding on gentler granitic soil sites using a mixture of pubescent, intermediate, and crested wheatgrass, fall oat, rye, and bitterbrush. Competition from existing vegetation was eliminated in June by disking. Planting will be done during October. This watershed will be used for further reseeding research on the more depleted, steeper sites which we presently do not know how to rehabilitate. Further action programs on the watershed will be formulated from answers obtained on these sites.

Cooperative treatment of skid trails and haul roads

The current Beaver Creek timber sale on the Boise Forest involves about 25,000 M fbm. It includes a variety of conditions insofar as tractor skid trails and haul roads are concerned. One of the more important problems requiring solution in the ponderosa pine region is that of determining how to stabilize skid trails and roads, and thus minimizing erosion and downstream sedimentation. The magnitude of the Beaver Creek sale area as compared to the relatively small operation on the Experimental Forest presents considerably greater opportunity for selecting comparable skid trail and, especially, haul road sites for study.

A number of skid trails and sections of haul roads on sites of different gradients and aspects are being selected in cooperation with the timber management staff on the forest. As these skid trails and haul roads receive post-logging treatment this fall, these particular trails and section of road will receive varying erosion control treatments. Tentative plans for the treatments include different spacing of slash plugs on skid trails and different spacing of cross ditches on haul roads.

The condition of skid trails and of road surfaces on these test sites will be observed from time to time and especially after heavy summer storms and spring snowmelt runoff to determine the effectiveness of each treatment on each site.

Meetings

In May Packer conferred with the Sawtooth Forest staff concerning watershed protection criteria developed for granitic soil foothill ranges. This meeting resulted in clarification of several points regarding the place of protection criteria in proper use standards being developed by Sawtooth staff. A similar meeting was held in June on the Boise.

Haupt and Packer attended the Western Snow Conference in Boise in June and participated in the SAF field day held on the Beaver Creek logging operations of Boise-Payette Lumber Company, the Experimental Forest, and logged state lands in Boise Basin.

Manuscripts

Packer completed an illustrated manuscript on the specifications, construction, and operation of the Intermountain Type-F infiltrometer. Haupt and Packer completed revision of a manuscript on the soil moisture-root development-seedling mortality study on granitic soil foothill range.

Wasatch Research Center

Davis County Experimental Watershed

The Chief, upon recommendations from the Director and Regional Forester (R-4), officially designated a 28,000-acre portion of the Wasatch N. F. as the Davis County Experimental Watershed. This area has gained wide recognition as the site of the development and successful application of upstream summer flood prevention measures. It also embraces several watersheds on which fundamental influence research studies are under way. The long-term nature of these studies warranted the designation of the area as an experimental watershed with the same considerations for its administration as experimental forests and ranges.

To meet growing demands for information, Marston prepared a 19-page illustrated brochure "Guide to Davis County Experimental Watershed." Several hundred copies of this report have been given to visitors during conducted Show-Me-Trips during the past summer.

The field work of reinventorying the plant cover on two of the experimental watersheds was completed this fall by two graduate students from the University of Utah under provisions of a cooperative agreement with that institution. Analysis of the data is now going forward, each student being responsible for the preparation of a report on one watershed.

Sixteen plots, each 25 x 30 feet in size, were cleared of vegetation and seeded to grass last fall as the first step in a detailed study of interception, evapo-transpiration, overland flow, erosion, and water available for streamflow. Drought conditions prevented the establishment of a satisfactory grass stand this year. The plots will again be seeded. Meanwhile, soil samples will be obtained this fall to determine the variability of depletion moisture contents within and between plots. It is also planned to complete the installation of Coleman soil moisture units on each plot this fall or next spring, so as to obtain supplemental detailed information on the march of soil moisture, changes in storage opportunity, and daily rates of evapo-transpiration.

Northeastern Forest Experiment Station

Upper Darby, Pa.

SEMI-ANNUAL REPORT ON

FOREST INFLUENCES

October 1, 1953

FOREST INFLUENCES

GENERAL

By Herbert C. Storey

The report "Effect of 15 years of forest cover improvement upon hydrologic characteristics of White Hollow watershed" prepared by TVA as of June 1951, presents some very interesting data. Analyses of hydrologic measurements during the 15-year period shows that there has been no change in total water yield from the watershed, nor has there been a shift in the seasonal runoff pattern as a result of land use changes. Although there has been a considerable increase in the amount of forest cover, there appears to be no increase in evapo-transpiration water losses. Evidently any increase in transpiration has been balanced by a reduction in evaporation.

Apparently streamflow hydrographs were divided into two elements: groundwater flow and surface runoff. The item "surface runoff" evidently includes all storm flow after groundwater flow has been removed. Storm flow was not broken down into surface runoff and subsurface storm flow. The analyses showed no change in the amount of groundwater runoff nor for the item they designate as "surface runoff". The major change observed was in peak discharges during the summer season. These peak discharges have been very greatly reduced during the period of observation. They further found that the time distribution of "surface runoff" has been materially changed. With the reduction in peak flow a higher flow was maintained for a number of hours after the storm.

The report attributes the change in storm hydrographs to a modification of rainfall intensities by the increased foliage, increased roughness due to litter accumulations, and increased opportunity for temporary surface storage of storm water. Although these factors may

have had some effect, there is considerable doubt as to whether they really explain the change in storm hydrographs. For one thing, a recent study on the Fernow Experimental Forest showed that a hardwood forest canopy had a very small effect upon rainfall intensities. The effect was certainly not of a magnitude that would play a very important part in explaining the reduction in peak flows as shown in the White Hollow watershed study.

There is a very good chance that if storm hydrographs were divided into surface runoff and subsurface storm flow the true reason for the change might become evident. As shown by the study, the greatest change occurred during the first year or two of the study. In this short time infiltration capacities might easily be increased, but percolation capacities through the soil profile would probably be little modified. An increase in infiltration capacity would cause a reduction in surface runoff, but with no increase in percolation capacities there would probably be an increase in subsurface storm flow. Therefore, the reduction in surface runoff would result in a reduction in storm peaks, and an increase in subsurface storm flow would cause a higher sustained flow for a short period following the storm. Thus, total amount of runoff for storms would be unchanged but the time distribution would be considerably altered. Further evidence of this possibility is given by the fact that sheet erosion which was quite prevalent at the beginning of the study became practically non existent towards the end of the period. This could quite easily be explained by a reduction in true surface runoff.

DELAWARE BASIN RESEARCH CENTER

By Nedavia Bethlahmy

Precipitation

Total precipitation on the Dilldown watershed during water year 1953 will again exceed 50 inches. It appears now that the average annual rainfall for Dilldown should be approximately 50 inches.

Although the total rainfall for the year will be equal to or greater than normal, several prolonged periods of drought were experienced during the past summer that had a considerable effect upon soil moisture and groundwater supplies.

An analysis of size of storm for Dilldown has been made and shows that although 45 percent of the total storms that have occurred during the past four years have been only .3 of an inch or less, these storms have produced only 9 percent of the total rainfall.

Soil Moisture

Due to the extended drought periods during the summer, soil moisture levels were extremely low. As a matter of fact, in one portion of the Dilldown watershed even the hardy scrub oak wilted.

We have had fiberglas soil moisture units in the ground since October 1949. We are now beginning to experience some difficulties with these units. Every so often another unit becomes useless. In these units two electrical circuits are involved: a temperature and a moisture circuit. So far we have had trouble (on different units) with both circuits. Any one contemplating the use of this type of soil moisture unit should certainly plan to use duplicate units at each depth.

Interception

It was possible to abandon most of the interception stations in scrub oak cover this year. After 3 years of throughfall measurement, the relationships obtained were following a pattern so similar that no further improvement could be made. Stemflow relationships, although a little more variable, were still satisfactorily consistent. Furthermore, the useful life of a stemflow installation is no more than two or three years. After that time, the stems are affected by the collars and become unhealthy or dieback.

Throughfall measurements are being continued in the high forest area along the creek. This station was enlarged to increase the number of measurements under a rhododendron understory.

This year, interception studies were begun in our coniferous stands at Dilldown. Our main coniferous species is pitch pine, the majority of which is sprout growth. Both throughfall and stemflow is being measured under this sprout pitch pine. Most likely, this is a specialized case--relationships between this type and ordinary coniferous vegetation will no doubt be dissimilar. The sprout growth grows in clumps, with numerous stems from the old stump. Therefore, there are possibly more stems per unit area but a lesser crown cover.

Both stemflow stations at the Pocono Experimental Forest, in high forest cover, were reactivated along with one of the throughfall stations.

Cooperation

Another year's accumulation of soil moisture data as collected on the Dilldown watershed was sent to the Vicksburg Infiltration Project. We hope that these data will contribute to the very worthwhile results the fellows there are coming out with.

MOUNTAIN STATE RESEARCH CENTER

By Staff

Watersheds

Stream runoff, as a percentage of rainfall, from five forested watersheds on the Fernow Experimental Forest, shows the following seasonal pattern based on two years' observations:

	First Year - 1951-1952					Second Year - 1952-1953				
	Watersheds					Watersheds				
	1	2	3	4	5	1	2	3	4	5
Growing period										
Rainfall (inches)	26	26	26	26	--1/	21	21	21	21	22
Runoff (percent)	26	32	32	30	--1/	14	17	17	15	20
Dormant period										
Rainfall (inches)	34	32	32	32	32	30	29	29	29	29
Runoff (percent)	52	65	57	57	72	46	55	50	51	67

1/ The gaging equipment on this watershed was not in operation during the early part of the first growing season.

There is a much wider range between rainfall and runoff on a monthly basis. The percentage of runoff ranges from less than 1 percent in August to over 95 percent in January and February.

This terrific fluctuation emphasizes one of the water problems in this area--the wide range of available water supply.

It is interesting to note that water losses (obtained by subtracting total runoff from rainfall) are practically the same for the two years, although there is a difference of some 8 or 9 inches in total precipitation. The difference in precipitation shows up entirely in a difference in runoff for the two years. This only goes to bear out the established fact that runoff is a residual that is supplied after satisfying all prior demands on precipitated water.

Skid road erosion

Late spring rains of very high intensity caused more erosion from skid roads than occurred during the previous six months--when rainfall was more gentle.

A study was started in the spring of 1953 to determine if a vegetative cover could be established on skid roads by using chaff from local sources. These tests were made on skid roads that had been bulldozed and were considerably compacted. Use of the chaff was tested with and without fertilizer and lime, and with and without a mechanical disturbance of the soil surface.

Results of this study are as follows: 1. Mechanical disturbance showed no significant difference in the percent of vegetation (groundcover) or height growth; 2. the limed and fertilized plots showed a significantly greater percent of vegetative groundcover and significantly greater height growth of vegetation than the plots which were seeded but not limed and fertilized. The following table shows the results to date:

Treatment	Vegetation density	Height
	Percent ground covered	Inches
Seeded only	26.0	4.9
Seeded, limed, and fertilized	40.0	8.4
No seed or treatment	0.5	0.7

The color and vigor of the vegetation on the limed and fertilized plots looked much better than on the plots which were only seeded.

On all of these plots measurements will be continued for two more years to find out if the present vegetation reseeds and if the beneficial effects of treatment continue.

Sedimentation Study

During the summer of 1952 a logging truck road was built in a forested watershed. Previous to the construction of this road and periodically thereafter paired water samples were taken from this and another undisturbed forested watershed, which serves as a control. Sediment analyses were made on these samples.

Before construction, the amount of suspended sediment in both streams was low at all times and well within standards for domestic consumption. After construction, the amount of sediment in the stream from the watershed with the road increased, particularly after heavy rains. Water sample analysis showed a maximum of 173 ppm. from this stream. At the same time, the control watershed sample analyzed only 8 ppm.

This road has not been used as yet but is "resting" before logging starts in this hollow. After several months, the fine material has largely washed away from the surface of the road and the adjacent disturbed areas. As a result, the level of sediment carried by this stream is gradually approaching that of the control.

The purpose of this study is to evaluate the effect of a certain standard of road construction and use on sedimentation.

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

Forest Influences
Semi-annual Progress Report, April 1 - September 30, 1953

General

Our major project continues to be generation of support necessary to establish a division of forest influences in the PNW Station. That goal has not yet been reached, but some progress has been made in the right direction. Efforts to spread the word are continuing, and interest in watershed research is steadily growing. The need for it was presented to the Region 6 Advisory Council in August, and a lively interest in the subject was evident among the members.

H. J. Andrews Experimental Forest

It is particularly fitting that our infant research program should get its start on an experimental forest named in honor of the late Regional Forester "Hoss" Andrews, a man who was well versed in water problems. Formerly the Blue River Experimental Forest, it was dedicated and renamed last July. To some fifty people in attendance, the significance of our new program in watershed research was described as a part of a get-acquainted tour of the area.

The H. J. Andrews Experimental Forest was established in 1948 primarily for forest management studies although the suitability of the area for watershed research was recognized in its early development. Watershed management studies figure prominently in plans for the future.

First step has been the establishment of three experimental watersheds in old-growth Douglas-fir. Trapezoidal flumes were installed in September 1952, and a full year of calibration has just been completed. The Geological Survey has maintained the records and obtained rating data; but, beginning October 1, 1953, this arrangement was terminated in favor of maintenance by personnel stationed at the experimental forest. However, the USGS has shown considerable interest in the performance of the trapezoidal flumes and no doubt will continue to check on their behavior.

The future program of experimental work in these watersheds has been fairly well crystallized in a working plan prepared by Bullard. The drainages are characterized by extremely rugged terrain and have a generally northwest exposure. Their areas range from 180 to 260 acres. Planned activities include studies of the effect of different silvicultural systems on total water yield and water quality. No treatment is contemplated until 1956, at the earliest.

Elsewhere on the Andrews Experimental Forest, investigations have been concerned primarily with the evaluation of applied forest management. Admittedly qualitative, the work has nevertheless built up a fund of experience which can eventually be translated into better management.

Watershed management needs have received their rightful consideration in this learn-as-we-go process. Logging heavy material in steep terrain will always result in some degree of soil disturbance, but the eventual effect on water quality is subject to control. Some of the techniques are evolving from the work on the Andrews Experimental Forest and more will develop.

Demonstration of good watershed management often tells the story more effectively than many a printed word. We plan to apply what techniques seem practical in an intensively supervised cutting operation, and a watershed has been tentatively selected in the experimental forest for that purpose. Our hope is to carry out a demonstration of watershed management practices suitable for application in forested watersheds of the Pacific Northwest.

Mission Creek

Mission Creek near Wenatchee, Washington, has been designated as one of the 50 pilot drainages included in the Department's five million dollar program to test upstream works. One phase of the project will be an evaluation of land treatment applied over a 5-year period. We have cooperated with the Region 6 Flood Prevention Unit in the development of a preliminary working plan for studies designed to give some idea regarding the effectiveness of improvement measures. In spite of the obvious limitations in this type of investigation, it may serve as a forerunner of sounder research in that area. For some time, the PNW Station has had plans to build toward a major watershed research program in the Wenatchee Valley.

Columbia Basin Report

Preparation of the report on the overall program for the Columbia River Basin has been a long and complicated job. Various parts had been parcelled out among the agencies who were in a position to contribute. Among other things, the PNW Station was assigned the task of rounding up information on forest research needs and estimated costs. In August, Dunford assembled the material in a 40-page report which was submitted together with cost estimates for the 20-year program.

Meetings

In September, Dunford attended the convention of the Society of American Foresters at Colorado Springs. At the joint meeting of the Watershed and Range Management Divisions he gave a paper entitled "Surface runoff and erosion from pine grasslands of the Colorado Front Range."

Discussion

In the last quarterly report there were some interesting comments from the Piedmont Research Center on the subject of research in logging roads and methods. They bring out points that deserve some discussion.

In the Pacific Northwest we regard the combined activity of logging and road construction as the chief source of soil movement and siltation in forested watersheds. Questions most frequently asked us by land managers deal with the subject of logging and road erosion. Maybe we are not the ones to answer the questions, but certainly no one else is hastening to take up the challenge. Until somebody does accept it, logging activities will continue to be our No. 1 problem in watershed management.

In regard to the development of logging equipment, there are certain facts of life we might as well face. No logger or equipment manufacturer will voluntarily make changes in their gear and logging habits until they can be shown that cheaper logs will result. In spite of the troubles caused by tractors, it looks like they are here to stay as long as the logger has any choice in the type of equipment he uses. The Wyssen System and related schemes hold a lot of promise for reducing erosion, but if they are finally adopted in private timberlands, it will be only because they provide for cheaper logging--not because they reduce erosion.

We can exercise some control over logging methods on publically owned lands and are doing it in Forest Service timber sales. Certain restrictions have been placed on use of tractors so that compaction and erosion will be minimized. In the Douglas-fir region, we encourage use of high lead where possible for the same reason. However, standards have been difficult to set up because no one can say with assurance, for example, when a soil is too wet or a slope too steep for tractor operation. Guides such as these, which could be worked out by some well organized research, are really needed in the Pacific Northwest, and we aim to give them early attention, if possible.

Our last comment is to join in the plea for closer coordination of research effort. As a Division, we have been lax in analyzing the problems clearly. The national problem analysis proposed some years ago is still an acute need. With our inadequate financing we can't afford duplication of effort and nonproductive research while there are so many practical watershed management problems still remaining to be solved.

R - RM
REPORTS
Semiannual - FI

October 1, 1953

SEMIANNUAL REPORT
April 1 to September 30, 1953

Forest Influences Division
Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colorado

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GENERAL

The comments which we received from the San Dimas Research Center and from the Flood Control Survey Division of the Northeast Station were particularly appreciated. These comments dealt with our quarterly report of October to December 1952, wherein we pointed out some of the difficulties we had encountered in infiltration research. We shall consider the suggestions made and are grateful for them.

During the forepart of the summer, several 4"x5" color photographs were taken for the purpose of developing exhibits in range, watershed, and forest management research to be displayed at the Society of American Foresters and the Soil Conservation Society of America meetings. The color photographs are backlighted and provide an excellent display of the major activities of the Rocky Mountain Station.

Several new studies were initiated in western Colorado. The studies are coordinated with those of Range Research and are not solely those dealing with Forest Influences.

DELTA EXTENSION - VICKSBURG INFILTRATION PROJECT

Early in June, members of the Vicksburg Infiltration Project were assigned to Delta, Colorado, headquarters of the Upper Colorado River Research Center, where they initiated a project to study soil moisture and soil strength of the silt and clay soils in the vicinity of Grand Mesa. The sites selected for study began in the salt-desert shrub type at an elevation of about 5,000 feet and continued up the slope to the top of Grand Mesa. Sites were selected in the pinyon-juniper type, in the oak-brush type, in the aspen, and in the open park lands of the Grand Mesa in the spruce-fir type at elevations of 10,000 feet. At these latter sites, both dry and wet conditions were selected for study on soil derived from basalt and classified as silty clay and silt loams.

In addition to the soil studies, records are taken of temperature and humidity at the salt-desert shrub site, the oak-brush site, and on Grand Mesa.

The information obtained from the studies of these various sites will be extremely helpful in understanding the climatic and soil factors which govern the distribution and growth of the major types in western Colorado. The Station is indeed fortunate to be able to cooperate in this undertaking and to gain considerable basic information of the major forage types.

OAK-BRUSH CONVERSION STUDY

Much of the area in western Colorado is covered with oak (Quercus gambelii). The oak has invaded grassland areas and areas once occupied by ponderosa pine. It occurs at elevations 6,000 to 8,000 feet. Most of the invasion by oak occurred 75 years ago.

The present study is an inventory to determine the factors of climate and soil which govern the distribution and growth of oak, to classify sites which might be subject to treatment by poisoning or other means to remove the oak, and to ascertain the hazards of runoff and erosion once the oak is removed.

The factors considered in the study are the character and depth of soil, the present erosional activity, the composition of the vegetation, and exposure. These factors will enable us to classify the various sites as to the possibility of treatment.

The study for the present has been confined to Delta and Montrose Counties in western Colorado. From this study, we hope to be able to locate plots and small watersheds from which to measure runoff and erosion resulting from the removal of the oak. Not all slopes and exposures are conducive to the removal of the oak and not all areas have sufficient remnants of good forage plants to quickly replace the oak.

BADGER WASH COOPERATIVE STUDY

A cooperative study in western Colorado has been undertaken by the Bureau of Reclamation, Bureau of Land Management, Geological Survey, and the Rocky Mountain Station on the Badger Wash area near Mack, Colorado. The Badger Wash is representative of the salt-desert shrub type at elevations of about 4,000 feet in a rainfall belt of less than 10 inches. This type extends throughout western Colorado, eastern Utah, and southwestern Wyoming. It is a type where extensive runoff and erosion occurs from cloudburst storms.

Badger Wash, a drainage of about 3,500 acres, has been divided up into some 17 small drainage basins by the construction of a series of small dams in the tributaries of the main wash. This arrangement provided an opportunity to study the runoff, erosion, and sediment yields from this type of land where Mancos shales predominate. The initial phase of the study has been set up for a 20-year period.

The present objective of the study is to determine the effect of the total exclusion of the native vegetation from livestock grazing on runoff, erosion, and sediment yields from cloudburst storms. At a later date, studies in reseeding of the areas and possibly in grazing the various watersheds will be considered.

The general design of the experiment includes two blocks with four experimental watersheds in each block. The experimental watersheds range from 20 to a little over 100 acres in size. One block is on soils derived principally from Mancos shale and the other from Mancos shale and Mesa Verde sandstone. The vegetation in both blocks is representative of the salt-desert shrub. The Rocky Mountain Station will undertake infiltration,

erosion, and vegetation studies this fall; the Geological Survey will establish a rain-gage network and measure the catchment basins for total runoff and erosion from each of the watersheds; the Bureau of Land Management will fence four of the watersheds (two in each block) and will maintain the fences.

The Badger Wash study is one of the few in the salt-desert shrub type in the western United States. The determination of what native vegetation can do when left unused in the control of surface runoff and erosion forms the base from which to design a watershed-treatment program, particularly as to the intensity of structures required to reduce runoff and erosion. The land is under the jurisdiction of the Bureau of Land Management and the permittees using the area have agreed to the exclusion of the four small watersheds for the period required.

INFILTRATION STUDIES

During the period an analysis and manuscript were completed on the effects of livestock grazing on the infiltration rates of granitic soils at the Manitou Experimental Forest. These studies began in 1941 and 1942, were repeated in 1946, and in 1952. The 1941-42 studies constituted the pretreatment pasture values before the three degrees of livestock grazing -- heavy, moderate, and light -- were established in 1943.

The infiltration rates of the granitic soils of the pastures appear to be governed by the amount of dead organic materials (litter) on the soil surface and by the total pore space of the surface 2 inches of soil. Livestock grazing affected both these factors, by reducing the amount of litter allowed to accumulate on the soil surface, and by tending to compact the surface soil. Particularly are these effects pronounced in the heavily grazed pastures where the average infiltration rate was 1.10 inches per hour less than in the moderately grazed pastures, and 0.53 inch per hour less than in the lightly grazed pastures. The total porosity was 7 percent less in the heavily grazed pastures than in the moderately grazed pastures, and 3 percent less than in the lightly grazed pastures. It is concluded from the study that the three degrees of livestock grazing as employed on the experimental pastures had a real effect on the infiltration rates of the soils.

Before the quantitative differences between the different degrees of grazing on the infiltration rates of the soils can be determined, a major problem concerning the lightly grazed pastures must be solved. For example, the infiltration rates for the pastures heavily and lightly grazed were less, 48 and 25 percent respectively, than for the pastures moderately grazed. One would expect that the infiltration rates of the lightly grazed pastures would be equal to or greater than those of the moderately grazed pastures. This basic difference appears to occur throughout the period of the study and indicates that the pastures selected for light grazing may not have recovered from such past uses as cultivation, logging, and heavy grazing. The odd behavior of the lightly grazed pastures must first be explained before we can definitely determine the effects of livestock grazing on the infiltration rates of the granitic soils. Our first step will be to isolate those infiltration runs which occurred on the old cultivated fields which had been abandoned for some 25 years. At the present, about all that we can say is that livestock grazing has definitely affected the infiltration rate of the soil, but not how much.

DEFOLIATION OF SPRUCE BY BARK BEETLES

In our last semiannual report we summarized the effects of the defoliation of spruce by the bark beetle on the streamflow of the White River in western Colorado. As a supplement to that report, there follows a graph showing the average monthly streamflow of the White River as gaged near Meeker, Colorado, before and after the defoliation of the spruce by the bark beetles. The graph shows the gross effects on streamflow after the defoliation of the spruce by the bark beetle (fig. 1).

The average annual flow of the White River during the period 1934 to 1946 was 393,346 acre-feet; during the period 1947 to 1952 it was 501,883 acre-feet. This indicates an increase of 108,537 acre-feet; however, this increase is a gross difference and includes both changes in the weather and the effects of the defoliation of the spruce. The net effect attributed to the defoliation of the spruce is 77,062 acre-feet.

After defoliation the entire hydrograph for the White River has raised above the one existing before defoliation of the spruce. Streamflow from snowmelt (April to June) is more rapid than formerly and the spring peak is considerably higher. The low flows have increased with February being the month of lowest flow in each case. These changes in the hydrograph of White River are similar to those found in the Wagon Wheel Gap studies where comparisons were made of the streamflow between two small watersheds (200 acres each in size) one cut and burned and the other remaining an uncut climatic control.

The importance of the analyses of the effect of defoliation of spruce on the streamflow of the White River is important to all dealing with forest-management effects on streamflow. The defoliation of the spruce embodies the same principles of reduced snow interception as are now being studied at the Fraser Experimental Forest. The aforementioned graph provides an idea of what we may expect as a result of the logging of the Fool Creek watershed. It also illustrates the extension of the results of the experimental work to similar conditions found on a large watershed, in this case, 762 square miles in size.

PUBLICATIONS AND REPORTS

1. Love, L. D. Watershed management in the Colorado Rockies. Jour. of Soil and Water Conservation. Vol. 8, No. 3, May 1953.
2. Love, L. D. Watershed management experiments in the Colorado Front Range. Jour. of Soil and Water Conservation. (To appear in the Sept. issue.)
3. Brown, H. E. and Dunford, E. G. Characteristics of snow disappearance in the high Rockies. Manuscript prepared for release as a Station Paper.
4. Dunford, E. G. Surface runoff and erosion from pine-grass lands in the Colorado Front Range. Manuscript prepared and presented to the Watershed Management Division at the Society of American Foresters meeting, Colorado Springs.
5. Turner, G. T. and Dortignac, E. J. Range-watershed conditions in a mountain grassland. Manuscript prepared and presented to the Range Management Division at the Society of American Foresters meeting, Colorado Springs.
6. Love, L. D. The effect of the defoliation of spruce by bark beetles on the streamflow of the White River, Colorado. Manuscript prepared for publication in the Transactions of the American Geophysical Union.

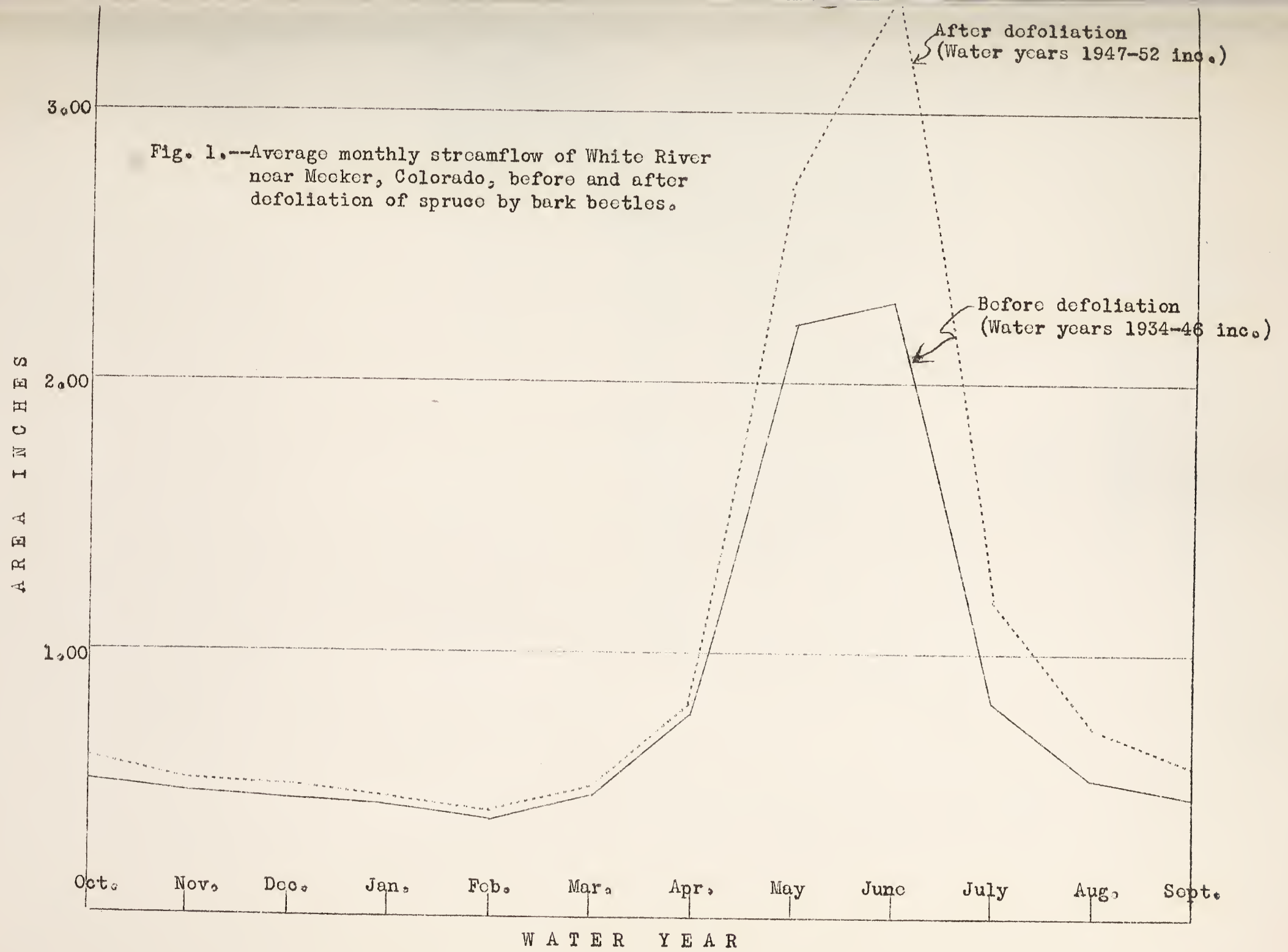


Fig. 1.--Average monthly streamflow of White River near Meeker, Colorado, before and after defoliation of spruce by bark beetles.

SOUTHEASTERN FOREST EXPERIMENT STATION
DIVISION OF FOREST INFLUENCES

PROGRESS REPORT
July - September 1953

Summary

SOUTHEASTERN FOREST EXPERIMENT STATION
DIVISION OF FOREST INFLUENCES

PROGRESS REPORT
July - September 1953

GENERAL

Hursh returned to duty August 3 after spending twelve months in British East Africa as a Senior Research Scholar under the Fulbright Program.

Johnson has been requested by the Graduate faculty of New York State College of Forestry to serve on the graduate thesis committee of students using or presenting Station data for their graduate theses. He has been previously called upon to serve in a similar capacity for graduate students from Michigan State. In all cases, students have spent or will spend six months to one year or more in employment at Coweeta.

Twelve Hundred Inches of Water a Year Goes Into Soil 1/

Great amounts of water used in processing frozen vegetables must be disposed of at Seabrook Farms, New Jersey, a concern processing 120 million pounds of vegetables in a year. All vegetables are washed (1 lb. of spinach takes 30 gallons of water; up to 13 million gallons of water needed per day for washing vegetables). The waste water, including waste organic matter from washed vegetables is transported through flumes. Disposal of this wash water is necessary. The water contains starch, excess leaves, salt, etc. It is not poisonous, but the State Health authorities do not want that water to go back into streams. This water is distributed over eighty acres of native woodland. As much as eight inches of water every day, 35 inches a week, 600 inches a year is put into the woodland as "artificial rain." One spot got over 1200 inches in a year, making it the rainiest "rain forest" in the world!

1/ Comments on ground water recharge by Thornthwaite. Conference on our Water Resources, Div. of Geology and Geography, National Research Council, Annual Report, '52-'53.

So much water released into the soil is unprecedented; therefore, is a scientifically interesting experiment, especially so because in initial experiments, water was run into sandy soil of a clover field, using a nozzle adjusted to an output of an inch in an hour. The field flooded in two hours, and the sandy soil became soup. The nozzle was moved to woodland that had never been cleared or cultivated, with the nozzle still set for an inch an hour. The nozzle fed water for 72 hours without stopping and there was still no sign of water on the surface. Then fifty inches were applied in ten hours. With more than four years of "rain" in four days, there was still no sign of water on the surface. The question Seabrook Farms would like answered: "What did man do to the soil of the sandy clover field by cultivating it that makes it different from the uncultivated woods?"

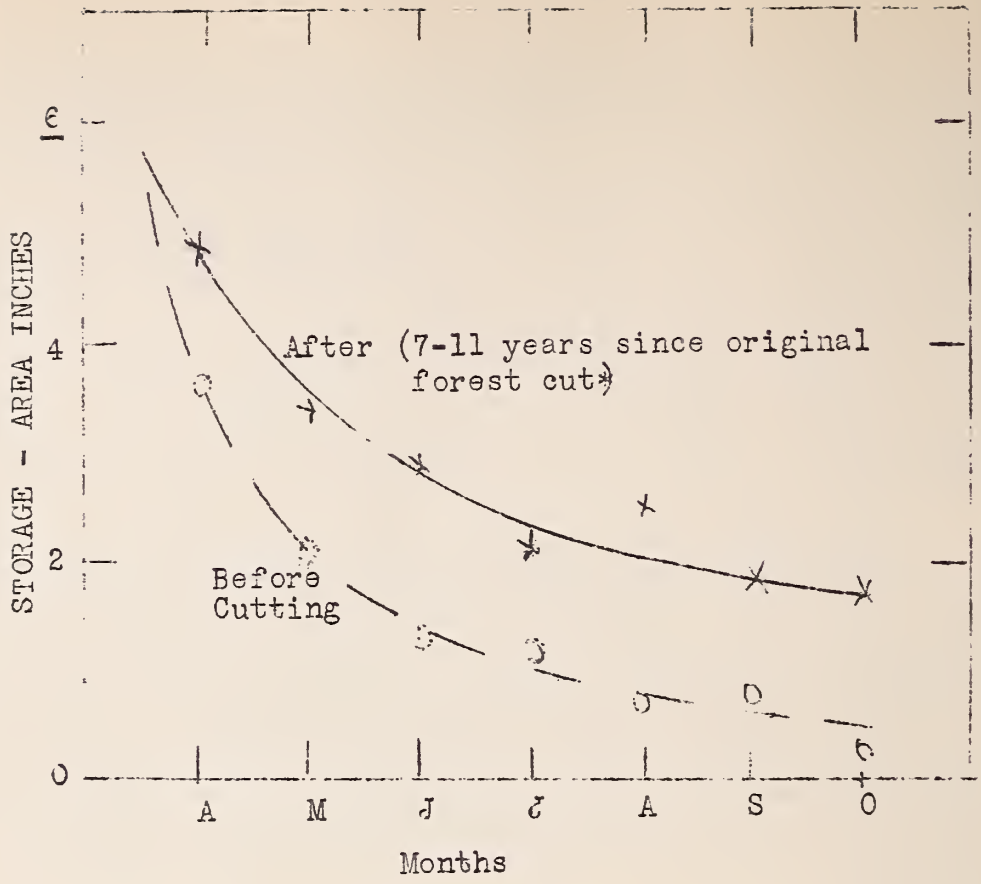
These woods provide a wonderful opportunity for research, and the U. S. Geological Survey sent two geologists to study the underground flow and ground water movement of this area. The study involves fifty ground-water observation wells spread through the woods, from which depth to water is mapped. The height of the water table above mean sea level, the depth to the water table, and the change in the level from weekly observation periods were noted. Studies were made weekly from May 1950 to the end of 1952, and show that actual improvement in the soil from the standpoint of infiltration capacity has occurred. The way in which the water table is changing is a possible assist in interpreting different reactions to water absorption.

Other scientific questions were: (1) What will happen to the vegetation? (2) Will the trees be killed off? (3) What changes will take place in the soil? When the program was begun, our workers were warned that the water would plug up the pores of the soil.

COWEETA HYDROLOGIC LABORATORY

Monthly Groundwater Storage on Watershed 17 Before and After Cutting Forest Vegetation

The influence of cutting forest vegetation on groundwater storage and change during the growing season is apparent when examining records. Ground-water storage is at a maximum both before and after treatment during the latter part of March. At this time soil moisture is quantitatively constant from year to year so the influence of clear cutting is minimized. Starting with maximum storage on Watershed 17 during March, the ground water depletes during the growing season. With reduction in evapo-transpiration, summer rainfall at Coweeta is sufficient to raise the soil to field capacity so that free water may pass through the soil to recharge ground water. These contributions to ground-water storage have changed the rate that ground depletes during the growing season (Fig. 1.).



MONTHLY GROUNDWATER STORAGE
Watershed No. 17
Fig. 1

Stormflow and Baseflow Proportions Before and After Complete Cutting Forest Vegetation

To evaluate effects of different land-management practices on the water balance it is essential that the stream hydrograph be separated into ground-water flow and the several components of stormflow. It is recognized that several methods are currently in use for separating ground-water flow and stormflow with each method yielding a different proportion of the total flow. The following technique was used in this study: A depletion curve was prepared for each watershed. This curve was then converted to read directly in gage height over the weir and adjusted to the time scale of the original field chart. This curve is then transferred to transparent cloth and used as an overlay on the original record.

Before cutting, the forest canopy completely covered the stream channel on the treated watershed. After cutting, the stream was exposed so rains fell directly into the channel. Even as a result of this treatment, maximum flows during storm periods have not been appreciably changed. Because of protection given to the soil no overland stormflow has been observed on these watersheds.

Before cutting, Watersheds 17 and 1 had similar amounts of total ground water and stormflow (Table 1). After cutting, the annual amount of stormflow remained approximately the same from the two watersheds. Practically all the increases in water yield from cutting the forest vegetation came from ground-water flow. This is attributed to a reduced transpiration draft by vegetation under this cover so that less rainfall is required to raise the soil to field capacity and more free water passes through the soil to recharge ground water.

Table 1.--Average, seasonal, and annual ground-water flow and stormflow from an undisturbed and clear cut watershed

CLEAR CUT WATERSHED 17

Season	Before treatment 1937-1940			After treatment 1941-1942		
	Total flow	Ground-water flow	Storm-flow	Total flow	Ground-water flow	Storm-flow
	In.	In.	In.	In.	In.	In.
Dormant	18.80	16.74	2.06	17.45	16.68	.77
Growing	9.09	8.36	.73	14.58	13.60	.98
Water Year	27.89	25.10	2.79	32.03	30.28	1.75

UNDISTURBED CONTROL WATERSHED NO. 1

	Period 1937 - 1940			Period 1941 - 1942		
Dormant	15.92	13.89	2.03	10.52	9.34	1.18
Growing	10.30	9.58	.72	7.74	7.08	.66
Water Year	26.22	23.47	2.75	18.26	16.42	1.84

Sprouting Vigor Changes with Annual Cutting

What has happened to sprouting vigor with annual cutting of natural regrowth is a frequent question asked by visitors when looking at Watershed 17. One facet of the sprouting vigor problem involves the effect of repeated cuttings upon size and number of sprouts. A cutting was made February 1953 of several acres of oldgrowth stand contiguous with Watershed 17 to provide an area having only one season's sprout growth for comparison with the main portion of Watershed 17. A comparable number of stems of the same species for both areas were measured during July 1953. Height growth was recorded as the vertical distance from the ground to the tallest growing point, Table 2.

Table 2.--Height growth of individual sprout clumps on Watershed 17 and on adjacent one-year coppice

Species	Minimum		Maximum		Mean	
	Area 17	1-Year coppice	Area 17	1-Year coppice	Area 17	1-Year coppice
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
Tulip poplar	5.0	1.7	6.6	5.2	5.73	3.10
Black locust	5.4	3.6	8.0	6.0	7.13	4.57
Red oak group	4.4	2.4	5.0	3.0	4.60	2.73
White oak group	4.0	3.0	5.4	4.8	4.50	4.00
Hickory	2.8	1.3	4.4	3.7	3.35	2.42
Red Maple	3.4	2.1	7.0	3.9	5.02	2.70
Basswood	5.8	3.0	7.8	4.1	6.63	3.40
Sassafras	4.0	1.9	5.8	2.0	4.90	1.95
Weighted Mean					5.38	3.36

Also the mean diameter of clumps and the number of stems in each clump were compared. Table 3. These comparisons are also for one-year coppice and Watershed 17, which was originally cut in the winter of 1940-41.

Table 3.--Diameter and number of stems per clump on Watershed 17 and on adjacent one-year coppice

Species	Mean diameter of clumps		Mean number of stems per clump	
	Area 17	1-year coppice	Area 17	1-year coppice
	Ft.	Ft.	No.	No.
Tulip poplar	3.50	1.50	6.3	1.3
Black locust	6.00	1.93	6.1	1.4
Red oak group	3.67	1.50	17.7	1.7
White oak group	3.20	2.10	12.0	2.2
Hickory	2.88	1.88	5.5	2.5
Red maple	3.62	1.25	10.2	1.8
Basswood	3.33	1.17	5.7	1.3
Sassafras	2.50	1.00	1.0	1.0
Weighted Mean	3.89	1.64	8.3	1.7

In the newly cut area most of the clumps could be classified as basal stump sprouts. The repeatedly cut area had not only stump sprouts, but also some vegetative reproduction that had developed on former root sprouts. A portion of the difference might be explained by type of vegetative reproduction on the two areas. It has also been suggested that the comparatively heavy drain on stored food in Watershed 17 may show a cumulative effect that expresses itself in the current year's growth.

Changes in Stand Composition 1934-1953, Coweeta Watershed 41

The permanent cruise lines established in 1934 at Coweeta are one of the few sets of plots in the Southern Appalachians that span the period during which chestnut was reduced from a major component to a rarity in the forest stand. Watershed 41 was typed in 1934 as predominately oak-chestnut with areas along the creek channel classified as cove-hardwood. The seventeen, one-fifth-acre plots that fall within this watershed form a line transect extending from the bottom of the watershed to the top--3250 to 4250 feet elevations--perpendicular to the general slope and crosses the two main branches of the stream on the watershed.

A comparison of 1934, 1941 and 1953 cruise data indicates some of the ecological developments during this period of adjustment following loss of the chestnut trees.

Table 4.--Basal area and stems per acre on Watershed 41 in 1934, 1941 and 1953

(All stems of tree species 0.5" d.b.h. and larger)

Species	Basal area			Stems		
	1934	1941	1953	1934	1941	1953
	Sq.ft.	Sq.ft.	Sq.ft.	No.	No.	No.
Chestnut	53.34	38.48	0.90	464.1	363.2	41.2
Hickory	18.80	16.11	20.70	138.2	153.8	182.4
Chestnut oak	10.49	10.14	14.19	75.9	73.8	61.8
N. red oak	9.83	9.68	5.18	73.8	62.9	24.7
Black oak	9.57	10.65	17.94	21.2	34.4	71.2
Buckeye	4.20	4.37	5.06	8.2	8.5	8.8
White oak	4.19	4.92	2.75	26.5	28.2	33.2
Black locust	3.90	3.42	2.06	36.8	48.5	16.5
Yellow poplar	2.94	5.54	12.98	95.3	141.8	152.1
Red maple	2.00	2.47	3.72	57.0	56.1	56.5
Black birch	1.98	2.07	2.96	15.0	15.0	25.3
Scarlet oak	1.50	2.17	6.94	4.7	14.1	10.9
Misc.	6.22	7.30	8.02	135.7	153.5	150.4
Total	128.96	117.32	103.40	1152.4	1153.8	835.0

One striking change during the 19-year interim is decrease in stand density in a forest which ordinarily should have been approaching a denser stocking. The principal reason for this occurrence is the reduction of chestnut from approximately 41 percent of the basal area in 1934 to less than one percent in 1953. Northern red oak had a minor reduction in both basal area (9.83 to 5.18 sq. ft. per acre) and in number of stems per acre (73.8 to 24.7) during the 19-year period. Observations indicate that the decrease in basal area and number of stems of black locust was primarily the result of reproduction being suppressed to the stage of mortality.

Most of the species responded favorably to the opening left by chestnut. The most striking increase was noted in yellow poplar, a relatively intolerant species. Yellow poplar increased from 3 to 13 sq. feet basal area between 1934 and increased in number of stems per acre with many of the yellow poplars now occupying dominant and subdominant positions in the crown canopy. White oak also slightly improved its role in the forest regime. Observations indicated that the decrease in its basal area was due to the loss of a group of overmatures from the stand but the remaining stems and reproduction will adequately overbalance this loss.

New species tallied for the first time in 1953 were: sourwood, cucumber, magnolia, yellow birch.

Analysis of streamflow records for this period indicates there have been no changes or trends in water yields with the decrease in basal area and adjustments in stand composition.

Observed and Calculated Depletion Curves

The normal depletion curve for a watershed is a useful tool in separating the components of storm hydrographs as well as for constructing a storage curve. It is difficult to define this curve accurately for a Coweeta watershed due to frequent and heavy rainfall during the growing season with the result that the corresponding stream hydrograph exhibits considerable stormflow and some accretion to ground water, thereby masking the recession curve of ground water alone. Many years of records are required before enough protracted dry periods are available so that the curve can literally be "pieced" together.

Figure 2 shows a normal depletion curve for Coweeta Watershed 18, obtained by regression methods. It is defined by the relation

$$Q = 10_e^{-.0119\, t^{0.655}}$$

where Q is the mean daily discharge in c.s.m. units and t is the time in days from the date of initial discharge of 10 c.s.m.

The observed stream hydrograph for the growing season of 1952 offers for the first time independent experimental verification of this estimate, which is based on data from previous years. Stormflow and accretion to ground water (as indicated by well records) appear as minor fluctuations on the main depletion trend which is very well defined. The hydrograph has one adjustment on the time scale for the period April 24 to May 2, when significant accretion to ground water occurred.

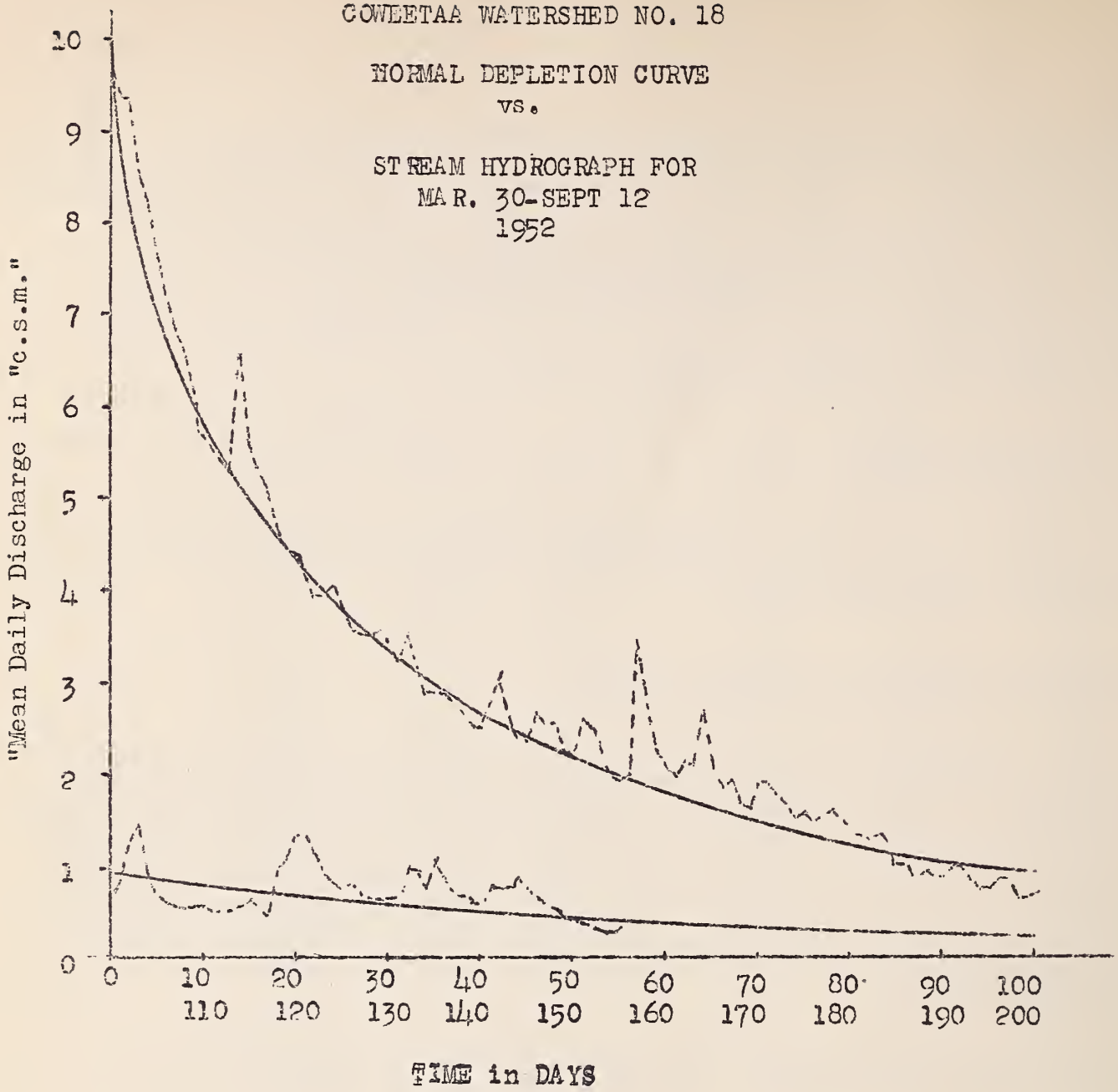


Fig. 2

The close agreement of the estimate with observation indicates that the former is a good approximation to the actual normal depletion curve and that the method of derivation may be used with confidence.

Further Studies in the Annual Water Balance

Total precipitation, total runoff and the difference between these two values are summarized for eighteen years in Table 5. This difference is accounted for chiefly as evaporation and transpiration and some interception. It will be seen that regardless of the total rainfall the values for the difference between precipitation and runoff are remarkably consistent.

Table 5.--Comparison of annual water balance values

Coweeta Watershed 2

Year	Precip. 11/1-10/30 year	Runoff 11/1-10/30 year	No adjustment for storage 11/1-10/31	Difference P-RO adjusted for storage: Nov.1-Oct.31	May 1-Apr.30	Apr.1-Mar 31	Hydrologic yr.*
	In.	In.	In.	In.	In.	In.	In.
1935	59.43	15.41	44.02	44.39			
1936	82.43	34.94	47.49	46.94	40.04	42.36	42.36
1937	70.08	29.83	40.25	40.11	43.68	42.51	44.64
1938	61.01	23.72	37.29	37.78	40.90	41.94	39.12
1939	69.93	33.89	36.04	36.14	41.96	39.83	40.59
1940	55.89	13.16	42.73	42.55	35.58	34.78	34.88
1941	47.99	12.20	35.79	36.00	38.02	40.32	39.94
1942	66.82	22.57	44.25	43.76	38.63	40.31	40.35
1943	74.04	32.87	41.17	41.12	42.21	40.35	40.00
1944	65.67	27.89	37.78	38.47	41.72	40.19	42.80
1945	62.92	16.73	46.19	45.97	43.37	44.54	43.25
1946	75.44	35.36	40.08	40.18	43.16	42.67	41.56
1947	65.38	20.82	44.56	43.91	38.72	40.81	39.12
1948	69.14	30.71	38.43	38.02	40.63	40.66	41.06
1949	103.41	53.38	50.03	42.27	38.98	40.09	42.13
1950	72.19	38.79	33.40	39.99	38.39	37.62	37.26
1951	62.12	28.87	33.25	33.93	39.09	36.53	36.96
1952	69.88	37.40	32.48	33.21	39.49	40.22	39.58
1953					37.39	39.69	40.19
Aver.	68.54	28.25	40.29	40.26	40.14	40.30	40.32
Std. dev.	11.69	10.50	5.15	3.98	2.30	2.28	2.39
Coef. of variation in percent	17.1	37.2	12.8	9.9	5.7	5.7	5.9

*Hydrologic year begins after first major storm at end of dormant season, generally around March 25.

Let us consider the analysis a step further. The primary storage equation "inflow equals outflow plus or minus changes in storage" is expanded for the water cycle to the form

$$P = Ro \pm I \pm E_T \pm \Delta R \pm \Delta S$$

P = precipitation
Ro = Streamflow
I = Interception
E_T = evapotranspiration
ΔR = change in retention storage
ΔS = change in ground-water storage

This formula can be given considerable hydrologic significance when applied on an annual basis to Coweeta watersheds as shown in Table 5. By using the derived ground-water storage curve we can assign a value to ΔS. By choosing the year so that retention storage is the same or nearly so at the beginning and end we allow that ΔR will be approximately equal to zero. Various 12-month periods have been used by different investigators to minimize ΔR and also ΔS where storage curves are not available.

With this in mind the precipitation-runoff data for a watershed have been subjected to trial balances for different 12-month periods in order to arrive at the best solution to the water balance. The data in Table 5 illustrate the main results of this analysis which apply to all gaged watersheds.

The P-RO coefficient of variation (c.v.) expressed in percent varies from 12.8 to 9.9 percent. The adjustment for storage only reduces the Nov. 1 to Oct. 31 c.v. from 12.8 to 9.9 percent. If the year begins and ends when the soil is at maximum retention storage in the spring as compared with the minimum in the fall we find that the c.v. is reduced to 5.7 percent. Year in and year out the watersheds tend to return to field capacity around April 1st. In the fall the soil moisture varies over a greater range from year to year.

The physical basis for the hydrologic significance of these results lies in the fact that the annual water loss to the atmosphere at Coweeta should show little variation from year to year where the vegetation seldom lacks for freely available water. This is evident from the high precipitation which is well distributed throughout the year. If ΔS and ΔR have been assigned correct values, then adjusted P-RO is equal to $I \pm E \pm T$, which is stable from year to year for the range of precipitation and other climatic factors at Coweeta.

The analysis can be carried a step further by assigning values to I, but it does not significantly alter the results as it turns out that range for the data in the table is only 2.5 inches.

Hydrologic Notes

Air temperatures were close to normal for the quarter although mean monthly minimum temperatures for August and September are the lowest on record. The differences, however, are not considered large enough to produce any significant deviations from normal in the various physical and biological phenomena.

Precipitation was below normal for the quarter, resulting in a deficit of 4.42 inches that brings seasonal totals to below normal levels.

A hurricane which moved into the Gulf of Mexico the latter part of September made its presence felt as it swept northeast across Alabama and Georgia. The main force of the storm was dissipated, with only 4 inches of rain recorded at the Laboratory. No unusual wind phenomena were associated with the storm.

Table 6.--Climatic summary of air temperatures and evaporation

Month	Monthly mean air temperature						Pan Evaporation	
	Average		Maximum		Minimum			
	16-yr.	1953	16-yr.	1953	16-yr.	1953	16-yr.	1953
	°F.	°F.	°F.	°F.	°F.	°F.	Inches	Inches
July	70.7	69.9	83.1	83.5	58.3	56.3	4.20	4.39
Aug.	70.3	68.3	82.9	83.7	57.8	53.0	3.84	4.64
Sept.	64.8	63.0	78.5	78.8	51.1	47.1	3.17	3.69

Table 7.--Precipitation Summary

Month	16-yr. av.	1953	Deviation from average	No. of storms 16-yr.	No. of storms 1953
	Inches	Inches	Inches		
July	6.60	4.84	- 1.76	16	8
Aug.	5.73	2.78	- 2.95	15	8
Sept.	4.45	4.74	+ 0.29	9	5
Quarterly Total	16.78	12.36	- 4.42	40	21
Water yr. to 9/30	66.26	64.65	- 1.61		
Cal. yr to 9/30	54.02	52.03	- 1.99		

Cooperation

North Carolina Wildlife Resources Commission and U. S. Fish and Wildlife Service.

The exploratory study on influence of poor logging from a tributary watershed on the number of trout food organisms in a larger stream was completed. This study started in December and completed in June was for determining if there were a difference in the fauna of a larger stream above and below the confluence from a poorly logged watershed. It should be kept in mind that logging stopped in 1948 and turbidity data indicate influence of the logging has materially decreased in recent years. Therefore any damaging influence from logging on food organisms as indicated by this study should be greater during and immediately after logging occurred.

Table 8.--Number and volume of bottom organisms in Shope Creek above and below confluence with logged Watershed 10 December 1952 to June 1953

	Above	Below
Number of samples	42	42
Average number of organisms per sq. ft.	36.8	30.4
Average volume of organisms in cubic centimeters	0.58	0.31

An analysis of variance of these data indicated that Shope Creek above the confluence with logged Watershed 10 produced a significantly greater crop of organisms than the sections below which were affected by logging.

Since Coweeta has a continuous measure on rates of streamflow, different techniques of the cresol method for making population studies on trout and stream invertebrates were tested by Fisheries' Biologists during August. In addition, population studies were made on the main streams of the Laboratory.

Food habits data have been collected this summer from all the game management areas of the Pisgah and Nantahala National Forests. This was undertaken in order to apply the results from this basic trout research project to other areas with greater confidence.

Universities

Three guest lectures were given at Michigan State College the week of September 28 to October 2. Conferences were held at the Engineering School, University of Michigan, with faculty members and students on watershed management and hydrologic research, using small watershed data.

Consultation

Johnson spent several days examining the salvage logging operation on the Clark's Creek Fire of the Cherokee N.F. during July. At the request of the Dayton Rubber Company, Johnson assisted in the water temperature problem of Hazelwood, N. C. This plant was specifically located in western North Carolina because of available water temperatures below 66°F. Recent stream temperature rises have been in the middle 70's. Field inspection revealed it was largely an engineering problem.

Visitors

Twenty-seven groups, a total of 272 individuals, visited the Laboratory during the 12 weeks of this quarter. This brings the total so far this year to 59 organized groups with a total of 772 visitors.

QUARTERLY PROGRESS REPORT

July - September 1953

PIEDMONT RESEARCH CENTER 1/

This quarter was characterized by some long hot spells in Union. During August there were 5 days when the maximum was 100° or higher and during July and August there were 42 days when the maximum was over 90°. Rainfall during the quarter was somewhat more than we have had during the comparable period of the past 3 years, and about 2 inches less than the 50-year average.

Climatic Summary - Calhoun Experimental Forest

Month	Average Temperatures			Highest Temp.	Lowest Temp.	No. of days with rain	Precip.	Evap.
	Max.	Min.	Mean					
	°F.	°F.	°F.	°F.	°F.		ins.	ins.
July	91	68	80	101	57	11	4.45	7.187
August	92	64	78	103	56	7	2.35	6.933
September	83	58	70	95	42	12	5.38	4.939

Topsoil

During this quarter several acres of topsoil from the Calhoun were used for preparing a roadbed prior to asphalting. Since the Forest Service placed restrictions on certain erosive soils, areas with too much slope, and fields with trees growing on them, the highway department was hard pressed to locate satisfactory pits. The highway department also has certain standards which must be met, such as texture of the material, and its depth on the field.

For the road through the Calhoun, which will have a bituminous surface 18 feet wide, a 6-inch layer of compacted porous surface soil is needed. This means that per mile of road about 2400 cubic yards of material must be used. Our road is about 5.3 miles long and to secure enough topsoil it was necessary to strip about 15 acres of land. About 5 acres of this came from the Experimental Forest.

1/ Joint projects of the Divisions of Forest Influences and Forest Management.

Tree Growth During 1953

In conjunction with the soil moisture project, height growth has been measured on 10 trees, and radial growth on 6 other trees, during the past growing season.

Table 1.--Height and growth of sample trees - 1953

Age of tree	Species	Total present height	Initial height	Growth
Years		Feet	Feet	Feet
25	Shortleaf	34.30	32.70	1.60
19	Shortleaf	34.55	32.40	2.15
28	Shortleaf	45.15	42.70	2.45
26	Shortleaf	42.30	40.70	1.60
31	Shortleaf (littleleaf)	38.80	37.80	1.00
30	Shortleaf (littleleaf)	42.70	41.50	1.20
14	Loblolly	38.05	36.20	1.85
14	Loblolly	37.80	35.80	2.00
14	Loblolly	38.15	35.60	2.55
14	Loblolly	40.40	37.60	2.80

Height growth started on the 4 loblolly trees during the first week of April and ended during the last week of July. With the exception of the two littleleaf diseased trees, the shortleaf started height growth during the last week of March and ended during the latter half of August. The two littleleaf trees, showing the least height growth, started growing the first week of April and ended during the latter part of July.

Radial growth started somewhat sooner than height growth and is still going on. The values given in the table below are for growth from the starting date to October 1.

Table 2.--Radial growth of sample trees - 1953

	Moisture plot number			
	1	6	7	
Species	Loblolly 2 trees	Shortleaf 2 trees	Shortleaf	Dogwood
Age	14	34	27	-
Growth started	Feb. 25	Feb. 25	Feb. 25	May 1
Growth stopped	Aug. 1	Aug. 1	Aug. 1	July 16
Growth resumed	Sept. 24	Sept. 3	Sept. 3	Sept. 24
Total radial growth	3.09 mm.	2.21 mm.	3.08 mm.	0.91 mm.
Total diameter growth	6.18 mm.	4.42 mm.	6.16 mm.	1.82 mm.

The pines show earlier growth than the dogwood. All trees stopped growing for several weeks during August and September and then resumed. Since resumption of growth in September there has been no further cessation or slowing of growth. To date the relationship of height and diameter growth to soil moisture has not been studied.

General

On August 28 the Center was in charge of a conference on "Water" for Soil Conservation personnel in the upper Piedmont counties. About 50 SCS technicians and supervisors attended. During the morning the Coweeta movie was shown and then Dr. Hursh discussed the water situation on the Piedmont. In the afternoon the group toured the Calhoun Forest. Much interest is being shown on the subject of water in South Carolina. At the present time the state is in the process of formulating a water law.

On September 16, the Calhoun was host to 14 senior and graduate students from Syracuse University. The group was under the leadership of Dr. Farnsworth, Professor of Silvics.

In the Sunday, September 20, issue of the Spartanburg Herald, the feature article in the Piedmont News section was about the Calhoun Forest. There were five photographs and the article covered such points as our research findings, how we try to answer problems of the National Forest and private landowners, and the financial returns that National Forests make to the Counties.

On September 24 Metz and R. J. Riebold, Supervisor of the South Carolina National Forests, represented the Forest Service at a meeting on Water Laws sponsored by the SCS at Chester, S. C. At this meeting Mr. C. E. Busby, SCS consultant from Berkeley, California, reviewed the evolution of present day water laws and explained why this state needs some new ones. The meeting was held primarily to give information to the SCS District Supervisors, the group that is spearheading the drive for new laws.

Personnel

Glenn P. Haney, Research Forester, arrived for work on August 18, from the Uwharrie District of the N. C. National Forests. He has a B.S. degree from Penn State and has completed all resident requirements for a Master's degree at N. C. State College. His work at this Center will be concerned with forest management on the Piedmont. Both Haney and his wife are from Erie, Pennsylvania, and they have a 5-month-old son.

SOUTHEASTERN FOREST EXPERIMENT STATION
DIVISION OF FOREST INFLUENCES

PROGRESS REPORT
April 1 - June 30, 1953

Summary

1/ Joint projects of the Divisions of Forest Influences and Forest Management.

SOUTHEASTERN FOREST EXPERIMENT STATION
DIVISION OF FOREST INFLUENCES

PROGRESS REPORT
April 1 - June 30, 1953

COWEETA HYDROLOGIC LABORATORY

Ten-Year Program Conference

Coweeta has operated under ten-year plans since its establishment in 1934. In continuance of this policy, a program planning conference for 1953-63 was called by Director Demmon for April 27 - May 1, 1953. The objectives of the Conference were stated as: (1) to review all large-scale watershed studies that have been conducted to date, (2) to make recommendations on the proposed experimental and demonstrational watershed studies for the 1953-63 period. Conference members from the Washington Office included representatives from the Office of the Secretary, and Forest Service Divisions of Watershed Management, Forest Management Research, and Forest Influences. Regions 7 and 8, the Southern and Northeastern Experiment Stations were represented. Southeastern Forest Experiment Station had conferees from the Divisions of Range Management Research, Forest Management Research, and Forest Influences Divisions.

A standardization committee was formed to prepare a report on the adequacy of present measurements and to provide recommendations on the measurement of water cycle variables during the 1953-63 period. A program committee was also formed to summarize the thinking of the conferees on the specific large-scale studies to be undertaken and to assign a relative priority to each proposal.

A condensed summary of the program recommendations and their priorities is shown in the following outline.

Large-Scale Studies - Watershed Treatments
Period 1953 - 1963

	Priority		
	High	Medium	Low
I. Changes in Streamflow Through Land Use			
A. Better Forms of Management			
1. Rehabilitate steep land agriculture with grass.		x	
2. Rehabilitate grazed woodland watershed by excluding cattle grazing and trampling.			x
3. Special studies on better logging (Plot or watershed).	x		
B. Poor Form of Management			
1. Continue exploitation of forest stand similar to poor practices on small non-farm woodlands.			x
II. Basic Studies on Water Balance			
1. Continue study on effect of slashing all vegetation with natural regrowth permitted.			x
2. Conversion from hardwood to conifer			
a. Convert cleared area to white pine (north facing watershed)	x		
b. Unmanaged forest, clear cut, replant to white pine (south facing watershed)		x	
3. Conversion from forest (hardwood) to grass	x		
4. Conversion from forest (hardwood) to shrub cover.	x		

	Priority		
	High	Medium	Low
III. Integration of Forest Management and Water Resource Management			
A. Silvicultural Treatments			
1. Unmanaged forest to even-aged managed forest through conversion.		x	
2. Unmanaged forest to selection forest having two degrees of stocking.			
a. Low residual stocking, heavy infrequent cut.		x	
b. Medium residual stocking, light frequent cut.		x	
B. Stand Variables			
1. Partial cuttings in relation to changes in water yield	x		
2. Age and maturity in relation to changes in water yield	x		
3. Site - Effect of cutting cove-hardwood type	x		

The Coweeta staff especially wants to thank the conference members and those of the Southeastern Staff whose cooperation and effort helped make this conference an outstanding success.

Mountain Farming - Soil Loss

The cumulative effects of mountain farming on soil erosion were shown to date in the June 1950 Quarterly Report. The three years' data since that time indicate an increasing rate of erosion. The well established gully system on the pasture and former corn field is enlarging and becoming a more prominent feature on the watershed as well as extensive channel-bank sloughing getting more apparent each year. Soil losses from the mountain farming, Watershed No. 3, are shown in Table 1.

Table 1.--Soil losses from steep land farming
Coweeta Watershed 3

Period	Land use	Years since converted from forest	Crops of corn	Soil loss	
				Average per day	Total
					Pounds
1934 - 1940	All forest	--	--	9	--
8/28/41 - 5/4/43	1/3 corn 1/3 pasture 1/3 sprouts	1st, 2nd	1st, 2nd	23	13,900
5/4/43 - 9/8/43	1/3 corn 1/3 pasture 1/3 sprouts	3rd	3rd	767	79,000
9/8/43 - 4/16/46	1/3 fallow 1/3 pasture 1/3 sprouts	3rd,4th,5th	3rd	46	44,000
4/16/46 - 3/28/47	1/3 corn 1/3 pasture 1/3 sprouts	6th	4th	38	13,500
3/28/47 - 4/13/48	1/3 corn 1/3 pasture 1/3 sprouts	7th	5th	43	16,200
4/13/48 - 4/8/49	1/3 corn 1/3 pasture 1/3 sprouts	8th	6th	91	32,900
4/8/49 - 7/11/49	1/3 corn 1/3 pasture 1/3 sprouts	9th	7th	1645	185,900
7/11/49 - 4/10/50	1/3 corn 1/3 pasture 1/3 sprouts	9th	7th	156	42,300
4/10/50 - 4/11/51	2/3 pasture 1/3 sprouts	10th	-	58	21,400
4/11/51 - 4/16/52	2/3 pasture 1/3 sprouts	11th	-	145	45,200
4/17/52 - 3/30/53	2/3 pasture 1/3 sprouts	12th	-	324	113,100
			Total		607,400

Effects of Poor Logging Practices - Soil Losses on Logging Roads

Logging operations on Watershed No. 10 were resumed in March 1953. This is the first major activity upon the watershed since the cessation of logging in December, 1948.

Table 2 indicates the amount of soil set in motion at marked cross-sections during the period of heavy activity (4/46 - 12/48) as well as during the after-logging period.

These data provide quantitative measures of soil losses on roads not bedded-down. Although erosion losses from a properly designed and bedded-down road are not available for comparison, observations have indicated that the losses would be far less than those indicated here for the dormant period.

Table 2.--Coweeta Watershed No. 10
Summary of Soil Loss Period 4/46 to 3/53
Before Rebuilding Road in 1953

(In Cubic Feet per Lineal Foot)

	4/46 12/47	12/47 12/48	12/48 12/49	12/49 4/51	4/51 4/52	4/52 3/53	Total
I	5.4	4.76	2.80	1.88	4.52	1.36	20.72
II	6.3	7.28	3.32	5.96	7.88	4.16	34.90
III	2.7	2.44	3.36	1.88	6.12	1.92	18.42
IV	6.6	1.00	3.08	1.92	2.32	1.64	16.56
V	16.7	.84	6.16	2.04	2.56	3.12	31.42
VI	5.1	1.32	1.08	2.08	1.12	1.16	11.86
VII	T	2.36	6.64	0.84	2.60	4.16	16.60
VIII	1.3	2.68	2.68	3.00	7.68	2.24	19.58
IX	Tr	2.08	3.96	2.44	1.20	0.68	10.36
X	Tr	1.76	1.84	1.68	0.72	Tr	6.00
Total	44.1	26.52	34.92	23.72	36.72	20.44	186.42
Mean	4.41	2.65	3.49	2.37	3.67	2.04	18.64

Effect of Understory Cutting Upon Growth of Vegetation Forming the Crown Canopy

Cutting of the laurel and rhododendron understory in Watershed No. 19 increased water yields an average of 3.64 area inches during the first two years following cutting. The increases in water yields during the third and fourth years have been substantially less.

A series of increment borings were made in an exploratory test and to compare growth rates before and after treatment. Observations agree with the conclusions of Wahlenberg in his September 1952 article in the Journal of Forestry, i.e., there appears to be an insignificant retardation in radial growth of crop trees by a heavy understory.

If a difference in growth rate is associated with removal of the understory in this watershed, the change is very small and would require a more refined technique than increment borings to substantiate it.

The Damage Has Been Done

The old adage that "a rotten apple will spoil the pack" applies to watershed management as well. The effects of bad watershed management go beyond the individual watershed being misused.

The Delaware Basin Staff of the Northeastern Forest Experiment Station reported the case of the Bethlehem City Watershed in their October - December 1952 Quarterly Report. Improper supervision allowed 25 percent grades with forest cover to be converted into surface bare boulevards with no provision for surface drainage.

A case history being enacted at Canton, North Carolina, points out the far reaching influence of bad watershed practices--not on its own watershed, but taking place on the holdings of another municipality.

The biggest point of issue in this year's city election at Canton revolved around logging of the municipal watershed. The "ins" wanted to log the 800 acre Beaverdam watershed; the "outs" were against it. The "ins" were defeated and another multiple-use watershed will be at least four more years in the making.

Why the opposition to logging in the municipal watershed? The citizens went up in cries against logging because of reports and observations that had taken place on the Waynesville, North Carolina, watersheds. Improper supervision at Waynesville has not provided an adequate check on the operators' adherence to the specifications of timber sales contracts with subsequent watershed damage.

A single sorry job of logging a municipal watershed must not be considered a local situation. This case history attests to its regional impact.

Table 3.--Climatic summary of air temperature and evaporation

Monthly Mean Air Temperatures

Month	Average		Maximum		Minimum		Monthly Evaporation	
	16-Yr.	1953	16-Yr.	1953	16-Yr.	1953	16-Yr.	1953
	°F	°F	°F	°F	°F	°F	Inches	Inches
April	54.7	52.2	68.2	66.7	41.2	37.7	3.76	4.36
May	61.6	64.7	76.0	79.7	47.1	49.7	4.08	4.06
June	69.0	69.8	82.3	83.4	55.6	56.2	4.05	5.03

Table 4.--Precipitation summary

Month	16-Yr. Av.	1953	Deviation from average	No. of storms	
				16-Yr.	1953
	Inches	Inches			
April	5.83	4.54	- 1.29	9	10
May	4.35	3.17	- 1.18	12	10
June	4.56	6.69	+ 2.13	14	15
Quarterly Total	14.74	14.40	- 0.34	35	35
Water Yr. to June 30	49.48	52.29	+ 2.81	62	58
Cal. Yr. to June 30	37.24	39.67	+ 2.43		

Although the amount of precipitation is close to normal for the quarter, its occurrence has been spotty. The latter portion of April produced a dry spell and a 17-day dry period during late May and early June showed its effect on farm crops.

Several heavy hail storms occurred during the quarter. On the afternoon of June 13, hail stones approximately 1.25 inches in diameter covered the ground at Coweeta. On June 19, hail stones 3 inches in diameter were measured by Johnson and Tebo along the Dillard-Highlands road. The latter storm caused a good bit of damage to crops. Cars which were unprotected during the storm now have a distinctive washboard appearance.

Ground water and streamflow.--Ground water Well No. 14 provides us with an index of ground water levels. During early May of each normal year, Well No. 14 falls from its constant head of 2409.61 feet at the rate of approximately .023 foot per day throughout the season of heavy evapo-transpiration. Its level commenced to fall on May 15 of this quarter. On June 30th, the well level was measured at 2408.54 with an average rate of fall of .0231 foot per day.

Streamflow was markedly below normal for late May and early June with mean daily flow of less than 1.0 c.s.m. in the high elevation watersheds. Rainfall during the last half of June helped bring back streamflow to near normal at the end of the quarter.

Vegetation.--Seven areas of severe canker worm damage were spotted in early June on the Standing Indian Wildlife Management Area adjacent to the Coweeta drainage. The nearest infestation with severe defoliation was 200 yards from the nearest gaged unit-watershed. By the end of the quarter new foliage had appeared, making the areas difficult to spot.

Because of the impact that extensive defoliation could have on the controlled watershed approach used at Coweeta, plans are being made for spraying the areas in accordance with recommendations from Speers and Morkel.

Cooperation

1. N. C. State Wildlife Commission

During the past quarter, the fish biologist quartered at Coweeta spent the majority of his time in identification of bottom fauna samples, and in obtaining pre-treatment data for several proposed studies.

Table 5 gives an indication of the complexity of bottom fauna studies. Note the fluctuations in number of organisms as well as the changes in their relative composition.1/

1/ Genera and species lists can be found in Quarterly Progress Report, N. C. Federal Aid in Wildlife Restoration, Fish Division, April-May-June, 1953.

Table 5.--Average numbers of the principal bottom organisms from Ball Creek above the mouth of Watershed No. 14.

	Dec. 12, 1952	Jan. 13, 1953	Feb. 25, 1953	Mar. 16, 1953
Number of samples	6	6	6	6
Total number of organisms	200	187	75	250
Av. number of organisms per sq.ft.	33.3	31.1	12.5	41.6
Order				
Diptera	5.7	8.4	5.9	14.1
Trichoptera	11.6	6.3	0.9	2.3
Coleoptera	3.3	5.8	1.0	3.3
Pleroptera	6.8	6.6	0.5	3.5
Ephemeroptera	5.7	4.0	4.1	17.4
Odonata	0.2	0.2	0.2	0.0

2. Universities

A memorandum of understanding was completed in April with the N. C. State School of Forestry for a cooperative aid project. The project is to deal with a phase of the influence of forest vegetation on storage opportunity in forest soils.

Forrest D. Freeland, Jr., of Michigan State College, reported to Coweeta on June 25 to commence work on his doctoral dissertation. The tentative title of his thesis is "The Effect of Clear-Cutting and Annual Sprouting Upon the Characteristics of a Forest Soil."

Jerry G. Williams, also of Michigan State College, reported June 31 to work on his masterate dissertation. Jerry is working on Watershed No. 7 and his thesis is tentatively titled "Effects of Woodland Grazing Upon Changes in Vegetation."

Nelson presented the movie "Waters of Coweeta" and a discussion on watershed research at the University of Georgia on the evening of May 26 under the auspices of the Forestry Club.

J. M. Lopez of the University of Los Andes, Venezuela, returned for another month's training session primarily on methods of analyzing watershed data under the direction of J. L. Kovner.

3. National Forest Administration

A two-day training session on water resource management was held during the quarter for 23 professional foresters from Region 8. The Mississippi, Pisgah, and Nantahala National Forests were represented.

Visitors

Twenty-five organized groups visited Coweeta during the quarter with a total of 474 visitors. The tabulation below indicates the nature of the groups.

	Number of Groups
Elementary and High School	7
Forest Service	6
MSA and FAS	5
Forestry Schools	3
Other	4
	25

Comments

In making preparations for the Coweeta Program Conference, valuable assistance was obtained from many sources. One of the technical problems where assistance became necessary was in connection with obtaining an index of soil moisture. For those who are interested in installation and use of fibreglas soil moisture units we found a letter by Herbert Storey dated February 18, 1953 which provides some of the best guides encountered to date. We recommend this letter be published as a Station Paper to help other research men, forestry school faculty members and students undertaking soil moisture measurements.

Book Reviews

Micrometeorology, O. G. Sutton, New York, McGraw-Hill Book Co. 1953, VIII, 333pp, $8.50.

There has been an increasing interest and emphasis in recent years in the science of micrometeorology. Foresters, in particular, have an interest in this field. For example, the effect of vegetation, particularly trees, in producing a local climate has long been recognized by foresters.

The literature is not very extensive, Geiger's book[1/], translated from the German, being the first real contribution. Micrometeorology, the first book to be published in English and written by O. G. Sutton, Professor of Mathematical Physics, The Military College of Science, Shrivenham, England, is highly technical and is not recommended for the ordinary reader despite the advertisement by the publisher. A good knowledge of meteorology is required to appreciate the analytical treatment of the material. The so-called practical applications are not extensive enough to warrant searching out in the text. In general, it is a book for the expert.

For those interested in the theoretical development of the subject and qualified to read the text, the book is a worth-while addition to the library in that it brings together a great deal of material which in the past has been scattered through the literature. The references appear to be quite adequate.

Statistical Theory with Engineering Applications, A. Hald, N. Y., John Wiley and Sons, Inc., 1952. xii, pp 783, $9.00

There is a veritable flood of new books on statistics. For the most part the material is the same while each author strives to reach a particular audience or a new simplified presentation with numerous practical applications. It is quite obvious that there is a ready and profitable market in this sort of thing and the publishers are not backward in taking advantage of the situation. Most new blurbs read like the "learn to play the piano at home" ads.

The ordinary research worker is somewhat at a loss in knowing what books represent a worth-while addition to the library and deserve study. The station has acquired a copy of the new book by A. Hald. Published in conjunction with it is a separate volume of statistical tables and formulas, which are very handy and useable.

1/ R. Geiger, The Climate Near the Ground, Brunswick 1950.

Undoubtedly this is one of the better statistical books for the practicing researcher and this judgment is confirmed in the review given in the Journal of the American Statistical Association for June from which we quote: "From a practical point of view 'Statistical Theory' is far superior to anything which has been written to date." It is not as easy reading as Snedecor, but offers a much better balance between theory and practice for those that are interested in the former. The practical examples are well selected and the reader gains confidence in his ability to handle data using the ordinary statistical techniques.

An Introduction to the Theory of Statistics, G. Udny Yule and M. G. Kendall, New York, Hafner Publishing Co., 14th Edition 1950, xvii, 701 pp, $7.50.

This is an old stand-by and the latest edition has several new chapters and additional material which bring old chapters up to date by incorporating recent developments. This, of course, is one of the best elementary introductory tests to the theory of statistics.

It is not recommended, however, for the researcher who wants a rapid introduction to practical application.

QUARTERLY PROGRESS REPORT

April - June 1953

PIEDMONT RESEARCH CENTER 1/

Prescribed Burning

Many foresters are interested in the possibility of using prescribed fire on the Piedmont for hardwood control and to provide a better seedbed for pine. While there is some doubt as to the practicality of fire to accomplish these silvicultural objectives, the biggest question has been the effect of such fires upon soil and water. As a joint venture, the Hitchiti and Piedmont Centers are investigating the use of fire under guidance from the Management, Fire, and Influences Divisions of the Station. The task of the Piedmont Center is to determine the effects of fire upon soil and watershed conditions. The Hitchiti Center is studying other silvicultural aspects of fire.

One obvious effect of fire is to reduce the litter cover which protects the soil. Our first step in the investigation is to learn just how much litter is needed for protection against raindrop impact and the consequent soil sealing which causes erosion and surface runoff. It is hoped that the critical amount of litter and organic matter can be established for broad soil and slope classes. As an orientation study, a rainfall simulator has been set up to apply water to small trays which are filled with a standard soil and covered with various weights of pine needles. Rain has been applied at intensities of 3 inches per hour with drops falling 7 feet for some determination and 23 feet for others. The velocity of fall of natural rainfall is simulated by a free fall of 20-25 feet. One object of the present series of tests is to learn whether it will be necessary to use a greater free fall distance than the 7 feet which is typical of most infiltrometer studies.

When there is less than 3000 pounds of litter per acre on the trays appreciable soil loss begins and losses become very high with less than 1000 pounds. These values, of course, apply only to the conditions of the preliminary tests, and actual values will come from field experiments.

1/ Combined projects of Divisions of Forest Influences and Forest Management.

On the Hitchiti Experimental Forest, two plots were burned during April. Litter samples were collected before and after burning to determine amount of litter consumed by the fire, residual litter amount, and fuel moisture percentage at the time of burning. On each block, 15 samples each of one square foot were collected. After weighing, the organic portion of the sample was volatized in a muffle furnace and remaining material again weighed. This was done so that results could be expressed on a volatile matter basis because large and varying amounts of mineral soil are inevitably picked up when litter is collected. The square foot samples for before and after burning were located before burning and were about 2 feet apart.

Table 1.--Average weight of litter before and after burning and fuel moisture percent at time of prescribed fire, Hitchiti Experimental Forest

Block No.	Weight of litter		Fuel moisture
	Before fire	After fire	
	Lbs./acre	Lbs./acre	Percent
1	10,615	3,455	14.9
2	8,625	1,965	8.3

From the weight of the individual square foot samples, it is possible to estimate the percentage of the plots covered by various litter weights after the fire.

Table 2.--Percentage of block area covered by various litter weights

Weight of litter	Block 1	Block 2
Lbs./acre		
less than 1000	-	7
1000 - 2000	21	57
2000 - 3000	36	15
3000 - 4000	22	17
more than 4000	21	14

Soil Sampling

Procedures have been worked out to make effective use of the Utah Soil Sampling Machine. This machine collects an undisturbed soil core 3-3/4 inches in diameter to a depth of 6 feet. It has given excellent results on a wide range of Piedmont soils. Very nice soil profiles for display have been prepared from these cores, which are cut open to show structure and then fixed with vinylite resin. Soil Scientists of the S.C.S. are impressed with the possibility of making a library of typical soil series for reference use. Several demonstrations have been recently made of this equipment and a mounted profile prepared for use at an S.C.S. training school.

Samples collected with the machine are also used for determination of pore space, percolation rates, and bulk density. The machine is superior to other methods in that it obtains better samples, and saves much time in the field. It is possible to obtain a large number of samples in a day's work. This is important for, by any scheme of volume sampling, favorable moisture conditions are necessary. There are only a relatively small number of good sampling days in a year.

Dead Top of Loblolly

A recent visitor from Australia, H. D. Waring, looked over the leader dieback of loblolly reported in the March 1952 Quarterly Report. He believes the symptoms are similar to the dead top disease troubling Australian foresters on Monterey and Ponderosa pines. Their best explanation to date is that soil moisture stress is the cause. We are preparing a short note to describe this disorder.

Loblolly Plantation Failures

In several localities, deaths of planted loblolly pine are occurring in patches from 1 to 10 acres in size. The trees appear to have grown satisfactorily for 6 to 10 years but then limbs die, the crown becomes thin and tufty, and finally the trees die. In some areas, bark beetles have finished off the weakened trees while in others they have merely faded away. Almost without exception, the trouble has occurred on severely sheet eroded sites where the remaining soil is the lower B horizon of the original profile. The soil material is a red, very plastic, micaceous clay. In the future, loblolly should not be planted on such areas but rather sericea or some other crop grown to prepare the site for later tree planting.

The cause for the failure of planted trees is not definitely known but the soil is low in available nutrients and also has extremely poor physical properties. The Division of Forest Pathology is beginning an investigation of this problem.

Tip Moth

Young pines in the Piedmont are attacked almost universally by tip moth. However, generally a good recovery is made and tip moth is considered to be a minor pest. In an effort to learn just what tip moth does cost in growth the Forest Insects Branch of the Bureau of Entomology and Plant Quarantine is carrying out a spraying program in a few loblolly plantings in Union County. Various insecticides are being tested and 2 spray schedules. The growth of sprayed trees will be compared with that of unsprayed trees.

Trees growing vigorously apparently quickly recover from tip moth damage but trees of low vigor or growing in eroded spots are hard hit. Tip moth infestation may be the direct cause for the sprawling puny trees seen where erosion has removed all topsoil.

Revegetation of Barren Areas

The general scheme of revegetating eroded spots has been the use of check dams in small gullies and tree planting. This has not been a universal success. Other methods tried have been mulching with pine boughs, planting trees in pockets of hauled-in soil, and fertilizing the tree seedlings. All these schemes are expensive and only mulching has quickly reduced erosion.

Several tests have been made on the Calhoun Experimental Forest to try other methods. The most effective, to date, have been sowings of cool season crops. Fertilizer is required to obtain satisfactory growth. Cover crops planted have been crimson clover, tall fescue, vetch, rye grass, and oats. Fescue, crimson clover and rye grass have all given good results. Three hundred pounds of a 4-10-6 fertilizer plus 200 pounds of basic slag if legumes are sown gives good results but, of course, more fertilizer (up to 1000 pounds per acre) improves growth. The oldest test planting is 3 years old and is well vegetated although no fertilizer has been applied since planting. Once some sort of a cover is established to stabilize the area, volunteers of a variety of weeds seed in.

Plants sown during the fall are easier to establish because (1) soil temperatures are not excessive, (2) soil moisture is more favorable and (3) seedlings are not washed out by gully washing rains which are typical of spring and summer.

Although the cover crops will not produce saw logs they do reduce erosion in a hurry. Failure to produce saw logs is more an imaginary disadvantage than an actuality because there won't be many logs produced by pines planted on severely eroded areas. It also appears likely that once the area is stabilized, pines will either seed in or can be planted and then can be expected to grow fairly well.

Costs of this type of treatment are difficult to estimate as they depend on fluctuating seed prices and how much mechanical equipment can be used on the site. Perhaps a fair range of costs is $25 to $40 per acre. While this is not cheap it is cheaper than alternative methods which also stabilize the area such as mulching.

Personnel

Geoffrey Greene transferred to an assistant Ranger position on the Helena National Forest in June. His replacement is expected to report for duty in August.

SEMIANNUAL REPORT
Division of Forest Influences
April 1-September 30, 1953
Southwestern Forest and Range Experiment Station

In the future, work of the Southwestern Forest and Range Experiment Station will be reported by the recently enlarged Rocky Mountain Station. Forest-influences work will be continued in central Arizona at the Sierra Ancha Experimental Watersheds, with research center headquarters at Arizona State College in Tempe. Forest-influences work in New Mexico will be centered in the Upper Rio Grande Research Center located at the University of New Mexico.

Sierra Ancha Experimental Watersheds

Workman Creek timber harvest.-- On June 8, 1953, the station entered into a cooperative agreement with Salt River Valley Water Users' Association. This agreement will permit the Salt River Valley Water Users' Association to harvest the timber on the three Workman Creek Watersheds in accordance with the watershed-management plan developed last year. According to the agreement, the Salt River Valley Water Users will underwrite the experiment and will put into the studies somewhere between $8,000 and $10,000 over and above the money they realize from the sale of the timber.

During the past summer timber-cutting operations were commenced on the south fork of Workman Creek. The first cut on North Fork has been completed. This cut included "All of the broadleaf species such as alder and maple, that require large amounts of water during the growing season, growing along the living stream or immediately in or adjacent to seeps and springs ..." These trees were cut and laid on the forest floor. Wherever possible, these trees were felled away from the main stream course. To guard against excessive soil disturbance and to hold erosion to a minimum, none of the vegetation was removed or salvaged from this watershed. When compared with the timber-cutting operations on South Fork, this should separate the effect of logging operations on water and sediment.

Pinal Mountain burn.-- Pinal Mountain west of Globe, Ariz., burned during July 1951. The area covered by the burn extended from the top of Signal Peak in the ponderosa pine type down to the flat area at the foot of the mountain in the chaparral type. The area was reseeded and by the late summer of 1952 weeping lovegrass (Eragrostis curvula) had become well established in the chaparral area and had produced a good seed crop. Before opening the area to grazing, an exclosure was fenced near the middle of the reseeded area. Paired transects were established inside and outside the fenced area. The transects were 100 feet in length and permanently located. The intercept transects measured both basal width of grass clumps and crown width of all shrubs intercepted by the line.

Transects were first measured November 12-13, 1952. Grass density at that time averaged 0.61 feet per 100-foot transect, 0.72 feet inside the fenced area, and 0.51 feet outside the fenced area.

The shrubs had resprouted profusely and shrub density averaged 23.31 feet along the transects, 22.74 inside the fenced area, and 23.87 feet outside.

Except for the fenced exclosure, grazing was permitted over the area after November 1952. Utilization approached 40 percent of the perennial grass growth.

Repeat measurements were made on the transects during September 1953 after the first grazing season. The results are as follows:

Date of measurement	Average grass density per 100-ft. transect		Average crown area of shrubs per 100-ft. transect	
	Grazed	Protected	Grazed	Protected
November 1952	0.51	0.71	23.37	22.02
September 1953	0.77	1.06	27.40	24.30
Increase +	0.26	0.35	4.03	2.28

Ways to establish grass in the chaparral type are largely unknown. Wildfire usually does little except increase the density of the sprouting chaparral species. Natural reestablishment of grass in the intershrub spaces almost never occurs. On the Pinal burn artificial reseeding of the weeping lovegrass was successful. It is well established and seems to be holding its own with the sprouting chaparral and this may be one answer to the chaparral areas.

Another phase of the granitic soils problem at Summit.-- Data from the Summit watersheds in the granitic soil type were summarized in the Forest Influences Quarterly Report dated April 15, 1951. This report pointed out that these watersheds had not revegetated naturally after 23 years. The extremely delicate balance that exists between the protective vegetation and erosion had been broken before the study was initiated. Since protection from grazing had not resulted in rapid natural revegetation of these deteriorated watersheds, one obvious conclusion was that some aid to recovery, such as reseeding combined with some method of decreasing the harshness of the microclimate such as mulch, was needed.

During the past summer, four of the Summit watersheds within the fenced area were reseeded. The chaparral vegetation was grubbed out and used as mulch to shade the ground. A mixture of Boer lovegrass (Eragrostis chloromelas) and Lehmann lovegrass (Eragrostis lehmanniana) was then broadcast over the area.

The summer rains were about 25 percent above average in total quantity and were well spaced with the result that a fair amount of Lehmanns lovegrass came up and produced seed heads.

Two of these four reseeded watersheds, one north-facing and one south-facing, will remain ungrazed; two of the reseeded watersheds, also one north-facing and one south-facing, are to be moderately grazed after a grass cover is established. Comparisons can be made with the watersheds protected from grazing since 1926 and the two watersheds that have been continuously grazed.

Sediment yields from the reseeded watersheds were materially lower than from either the protected or unprotected watersheds. One season's measurements indicate that sloping gully banks and protecting an area with mulch seem to be effective methods of erosion control.

Study initiated on effects of poisons on sprouting chaparral shrubs.-- A randomized plot study was established in the spring of 1953 to determine which of two poisons, two methods of application, and two seasons of treatment is most effective in killing sprouting chaparral shrubs in the Southwest.

The two poisons used were ammate, and a mixture of 2,4-D and 2,4,5-T. The poisons were applied: (1) as a basal spray to the lower 6 or 8 inches of stem, and (2) painted on the stubs of cut stems. The seasons of treatment were: (1) early March, when all shrubs were dormant, and (2) May, when all shrubs were actively growing.

Admittedly one growing season is not a sufficiently long time to determine the final effect of poisoning treatments. At least one, and possibly two more growing seasons must pass before final conclusions can be drawn. In the meantime, the reaction of the different species to the different treatments at the end of one growing season may be of interest.

The following tabulation shows the number of live stems or sprouts at the end of the first growing season following treatment, expressed as a percent of the initial numbers of live stems for the March (dormant) and May (actively growing) treatments:

Live stems and sprouts after one growing season expressed as percentage of initial numbers (all species)

	Treated in March	Treated in May
D - T basal spray	14	3
D - T painted on stubs	80	32
Ammate basal spray - - -	62	78
Ammate painted on stubs	426	190
Check-- stems cut	168	156

From this data the effects to date can be summarized as:

(1) The 2,4-D -- 2,4,5-T mixture applied as a basal spray has resulted in the highest kill.

(2) Basal sprays were apparently much more effective than painting the poison on the stubs of cut stems.

(3) Treatment during the actively growing season was apparently more effective than during the dormant season with the D - T mixture, but the evidence at this time is conflicting regarding ammate.

The effects of the various treatments to date vary somewhat with species of shrub, as shown in the following table:

Live stems or sprouts after one growing season
expressed as percent of initial numbers
(March and May treatments combined)

Treatment	Quercus[1/]	Ceanothus[2/]	Rhamnus[3/]	Rhus[4/]
D - T basal spray	9	0	6	8
D - T painted on stubs	52	3	177	43
Ammate basal spray	66	58	103	97
Ammate painted on stubs	291	2	281	292
Check -- stems cut	153	58	528	245

1/ Quercus turbinella
2/ Ceanothus greggi
3/ Rhamnus crocea pilosa
4/ Rhus trilobata

As can be seen from the table, of the four main species tested, Ceanothus is the weakest sprouter and the most easily affected by all treatments. Rhamnus is the least affected of all species for all treatments except the D - T basal spray.

Some differences were noted in the manner in which the different species sprouted following cutting. Ceanothus and Rhamnus sprouts all arose from the stem left after cutting, mostly from above ground but some from slightly below the ground surface. Oak sprouts arose from both the cut stubs and from the roots at some distance from the main stem. Rhus sprouts arose only from the roots or from root crowns below the ground surface.

Upper Rio Grande Research Center

Evaluation of reseeding in the woodland-sagebrush zone for water-flow retardation and soil stabilization in northern New Mexico.-- Field work, employing the Rocky Mountain infiltrometer, started in the summer of 1952 and was completed during the summer of 1953. All available sites in the pinyon-juniper-sagebrush zone were sampled. This study includes infiltration, erosion, soil and vegetation measurements on 160 plots distributed on six sites. One site, Cebolla Mesa, was sampled in 1952 and again in 1953 to provide a measure of variation between years. Four conditions, native and reseeded under grazing and nonuse, were available on five sites and native and reseeded range under grazing on the other site.

Conclusions from this investigation should be available in the next forest-influences report.

Evaluation of range-watershed condition and trend in the woodland-sagebrush zone of northern New Mexico, employing the Rocky Mountain infiltrometer, was started during the summer of 1953 for the purpose

of evaluating watershed values under various range conditions in the woodland zone. This study covers one phase of the planned overall range-watershed condition and trend study for northern New Mexico rangelands. The general plan also calls for remeasurement of vegetation on protected and grazed plots established in the major vegetation zones in 1941 and 1942 by the Southwestern Station and National Forest Administration. Infiltration, erosion, soil and organic material measurements are part of this overall study. Field measurements were completed on two sites involving 24 plots.

Procedures similar to those employed in the watershed evaluation of reseeded lands were used. One major difference is the use of North Fork nozzles during the dry run to avoid soil disturbance while bringing surface soils to a constant moisture content. The North Fork nozzles were attached to the Rocky Mountain infiltrometer rainfall applicator so that either type of nozzle could be used when needed.

Cebolla Mesa grazing study on reseeded and native rangelands.-- A watershed evaluation on the Cebolla Mesa pastures includes installation of a long-term rain intensity recorder supplied by Leupold-Stevens. This rain gage employs an A-35 streamflow recorder. Operation of this gage has been entirely satisfactory since its installation in May 1953. The only maintenance needed has required winding of the clock about every 30 or 40 days. Where less frequent visits are contemplated the recorder can be modified to record continuously for much longer periods by adding additional pulleys and increasing the clock weight. These rainfall intensity recorders can be built for much less than the price now quoted by Leupold-Stevens.

Soil-moisture electrical units were installed in one of the crested wheatgrass pastures on Cebolla Mesa to provide additional field data for predicting forage yield in advance of the growing and grazing season.

Range-watershed conditions in mountain grassland and aspen in western Colorado.-- Dortignac analyzed the infiltration data collected in 1950 in western Colorado and assisted Turner in preparation of this material for final publication. Additional regression analyses are planned but the major portion of the study has been summarized and written. It is proposed for publication in detail as a Station Paper or possibly in less detail in the Journal of Range Management. A summary of the findings was presented by Turner at the Society of American Foresters meeting in Colorado Springs.

Replicated watersheds. Examination of Wagon Wheel Gap watersheds in Colorado.-- In July 1953 Fletcher, Gaines, and Dortignac of the Southwestern Station and Kirkpatrick and Hansen of the Regional Office examined the "old classic" Wagon Wheel Gap watersheds in Colorado. The purpose of this inspection:

(1) Determine applicability of findings to northern New Mexico watersheds.

(2) Suitability or advisability of reopening streamflow recording stations as part of the Upper Rio Grande research program.

Some preliminary findings are:

(1) Coniferous cover density apparently increased slightly on the untreated watershed since 1910.

(2) The treated watershed has practically a pure stand of aspen.

(3) Soils are very similar to other mountain soils in Colorado and New Mexico.

(4) Dams and V-notch weirs on both watersheds are still intact and usable with little or no repair work necessary.

(5) Apparently there has been very little sediment accumulation behind the dam on the treated watershed since the close of the study in 1926.

Possibilities for reopening this study appear very promising and a proposed work plan is being prepared. Reopening streamflow stations would provide information on whether:

(1) The treated watershed is still yielding more water than the control watershed some 30 years after cutting of all woody vegetation.

(2) Aspen cover is more or less desirable than coniferous from the standpoint of water yield.

Many other questions might be answered here by further watershed treatment.